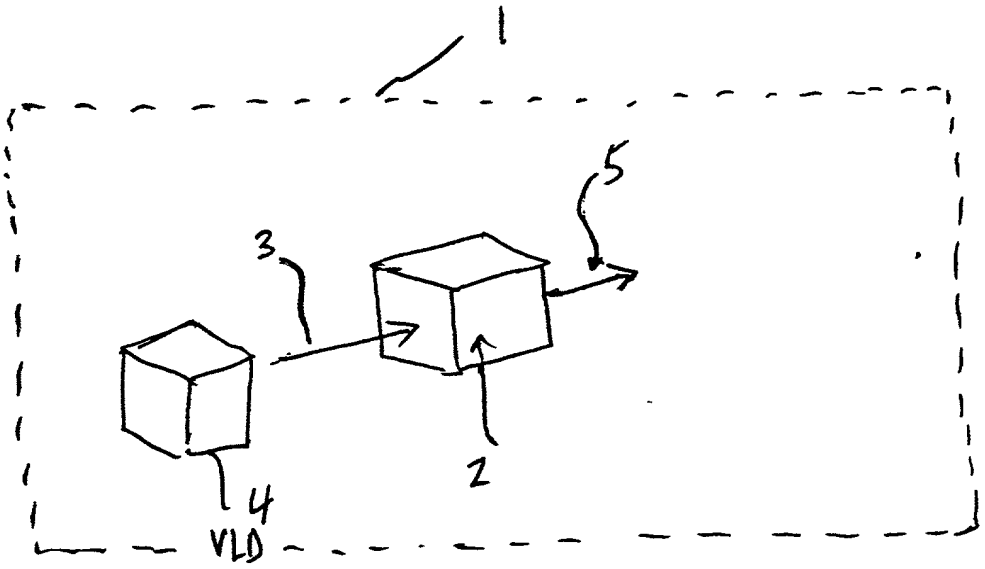


FIG. 1

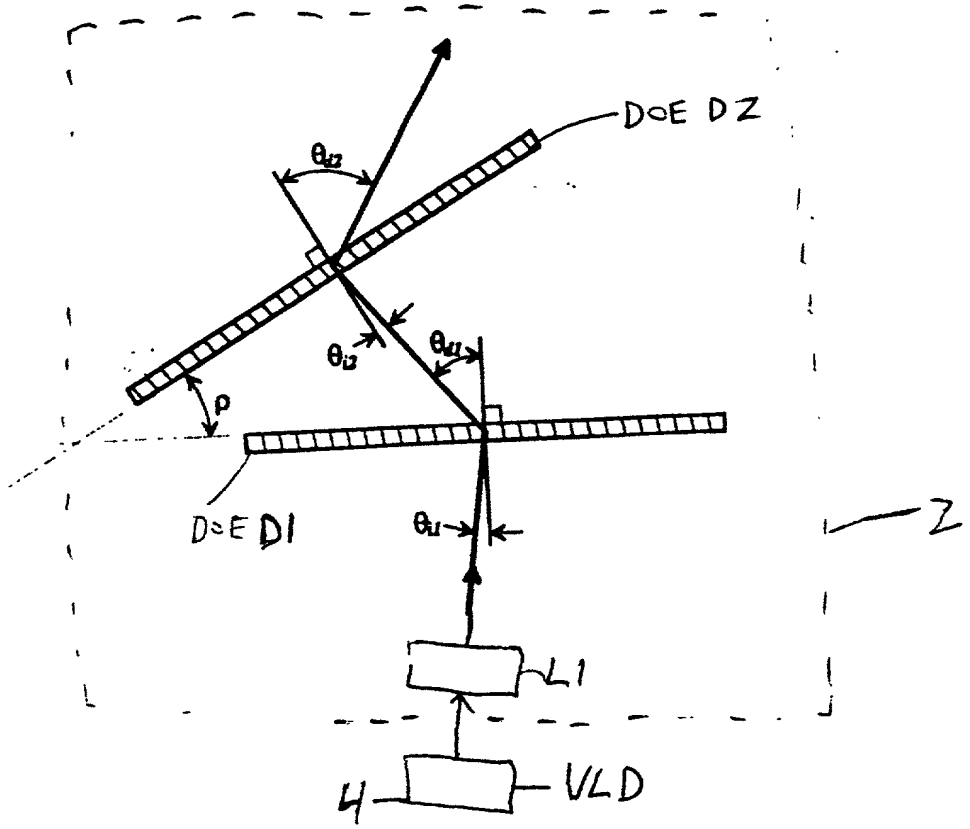


FIG. 1A

US 2006/0262568 A1 Nov. 23, 2006

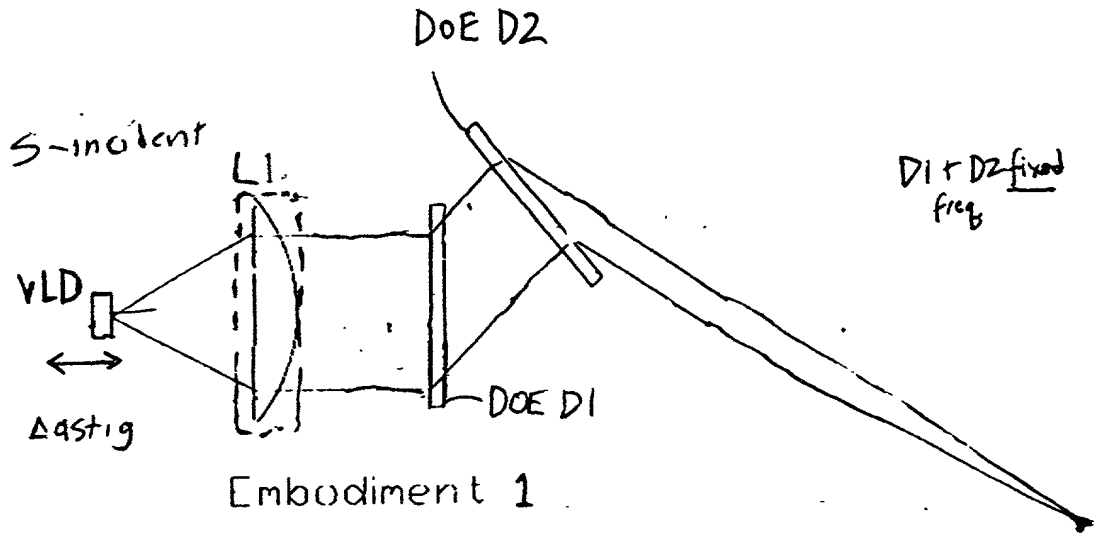

DoE D2
S-incident
L1
D1 + D2 fixed freq
VLD
DOE D1
Δastig
Embodiment 1

FIG. 2A

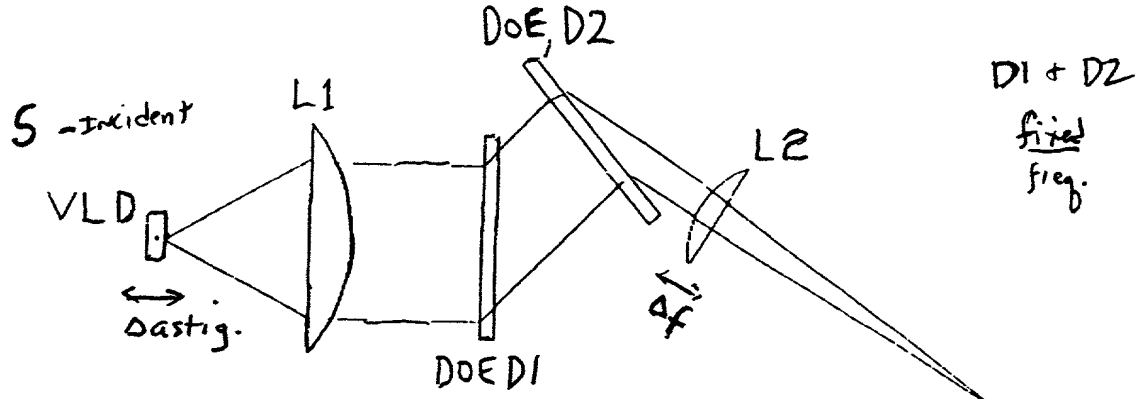


FIG. 2B

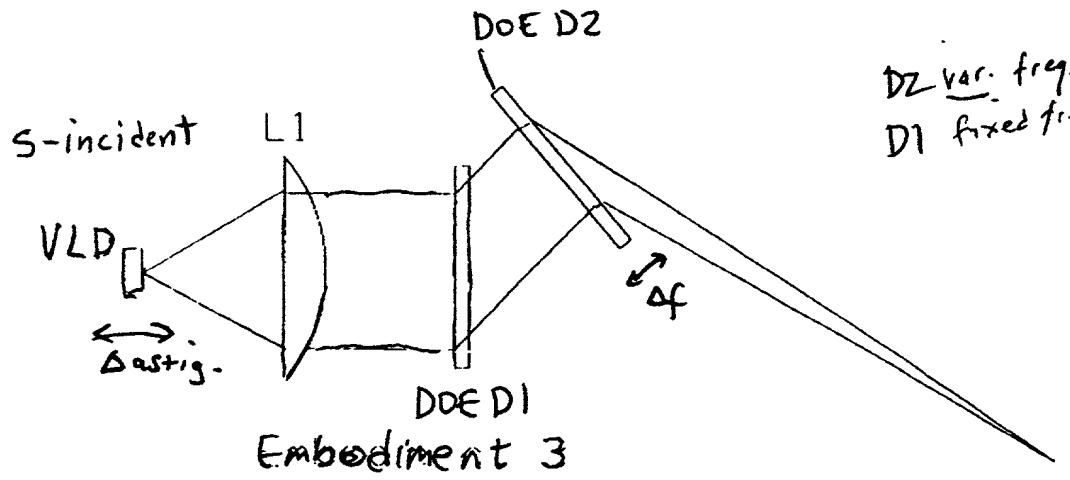
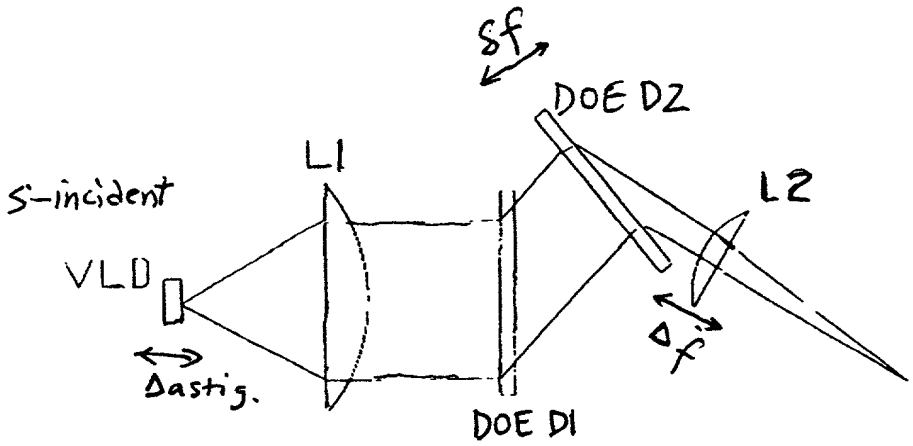


FIG. 2C

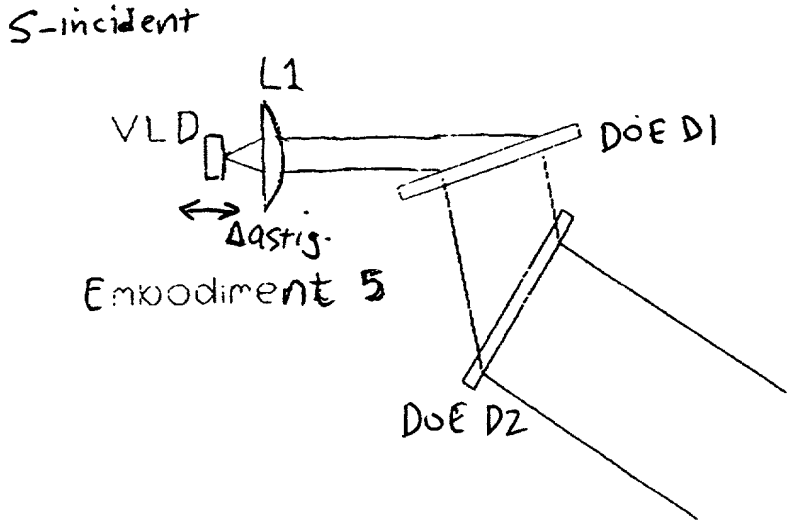
EP 2 926 196 A1



D1 fixed freq
D2 var. freq

Embodiment 4

FIG. 2D



D1 + D2
fixed freq

Embodiment 5

FIG. 2E

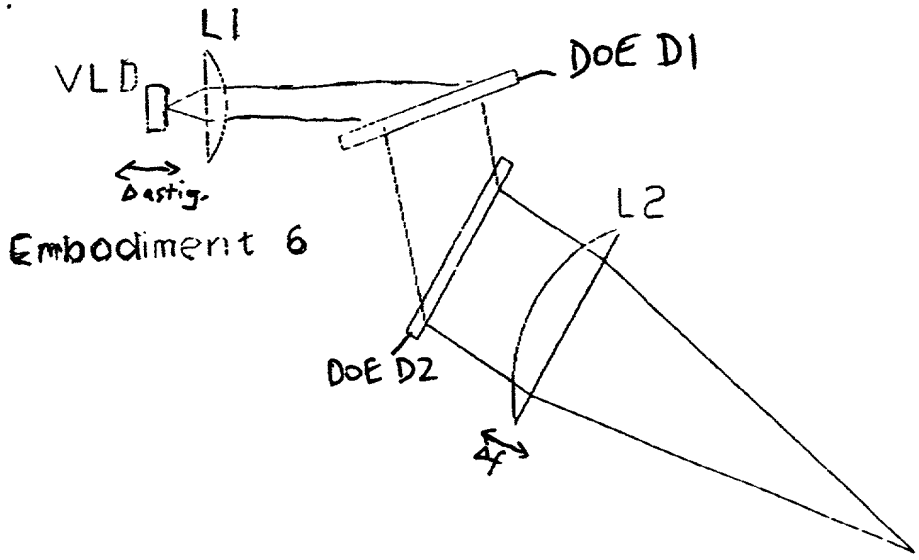

L1
VLD
DOE D1
Δastig.
Embodiment 6
L2
DOE D2
Δf
D1 & D2
fixed
freq

FIG. 2f

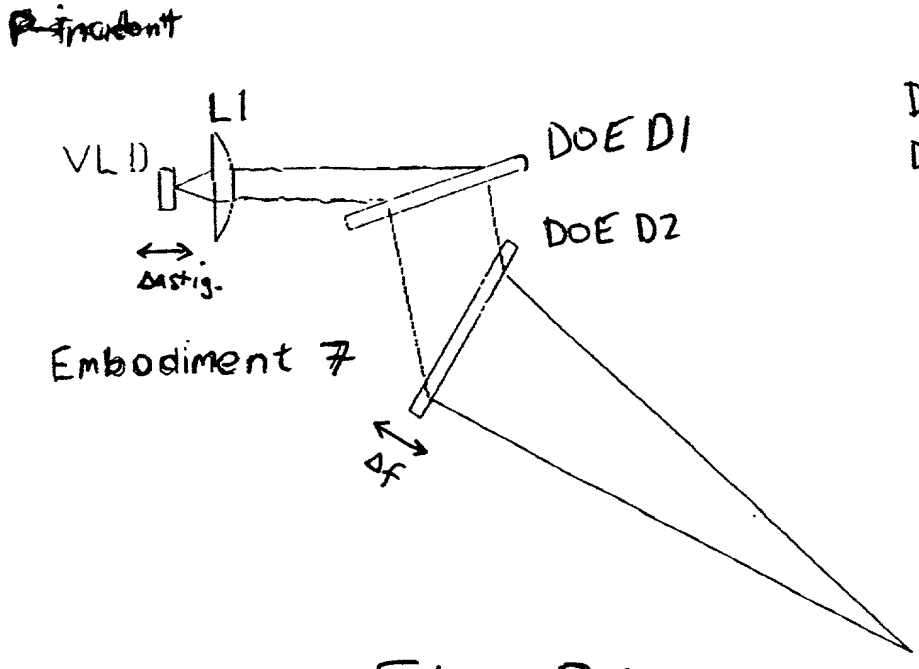
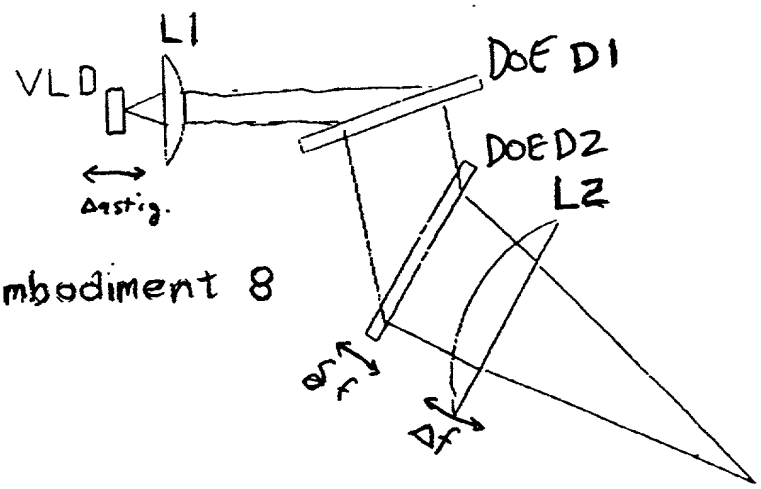

Embodiment 7
L1
VLD
DOE D1
DOE D2
Δastig.
Δf
D1 fixed freq.
D2 var. freq.

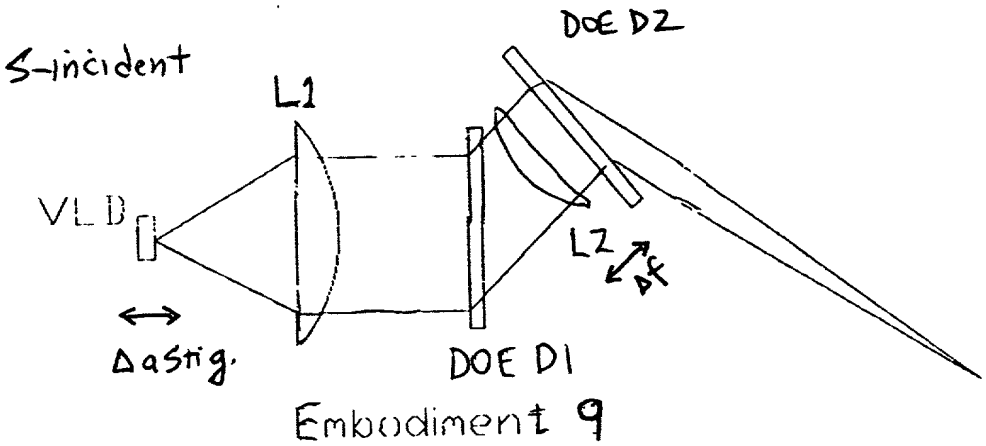
FIG. 2g

p-incident



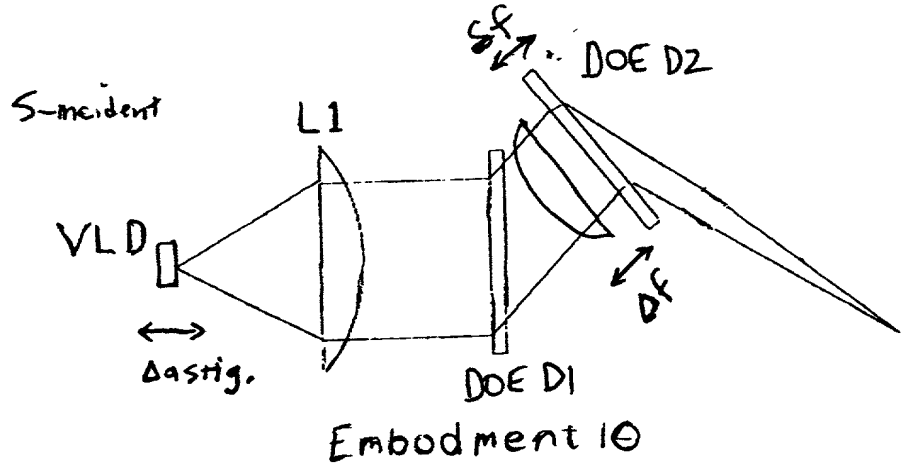
D1 fixed freq
D2 var. freq

FIG. 2H



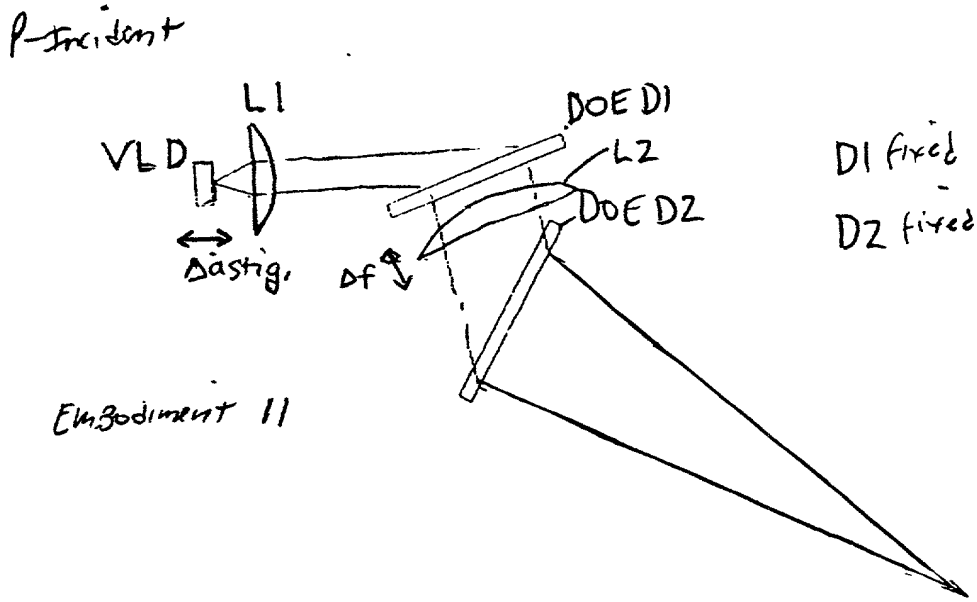
D1 + D2
fixed
freq.

FIG. 2I



Embodment 10

FIG. 2J



Embodiment 11

FIG. 2K

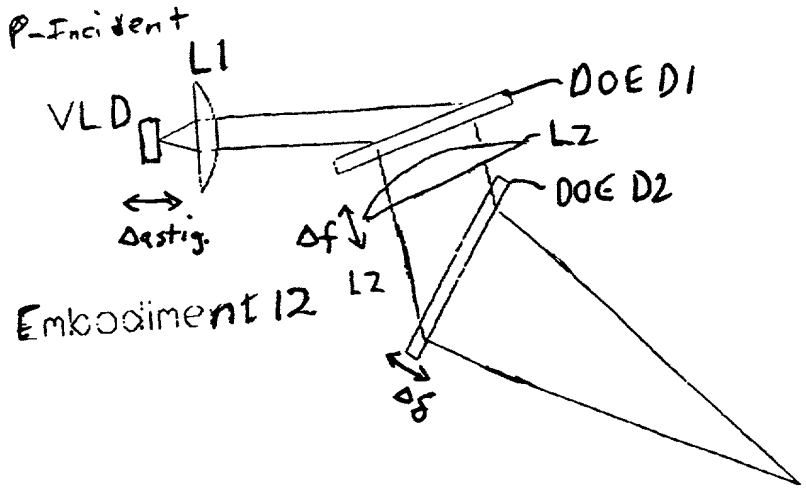
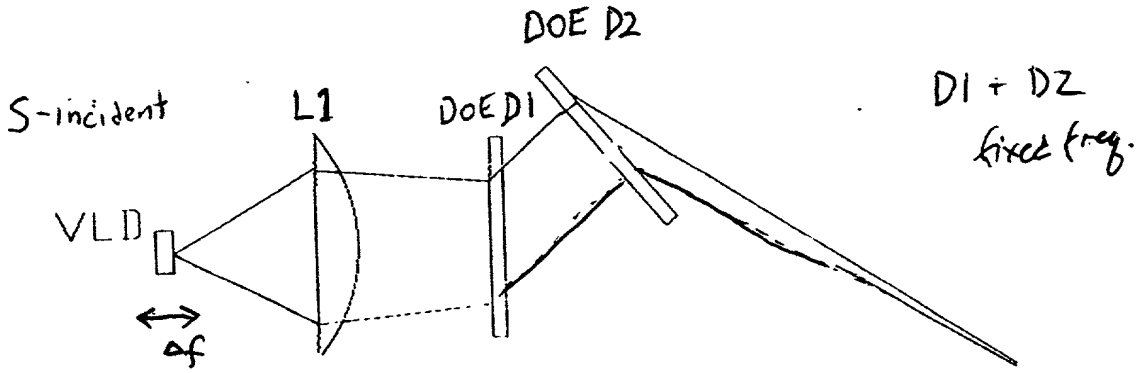


FIG. 2L



Embodiment 13

FIG. 2M

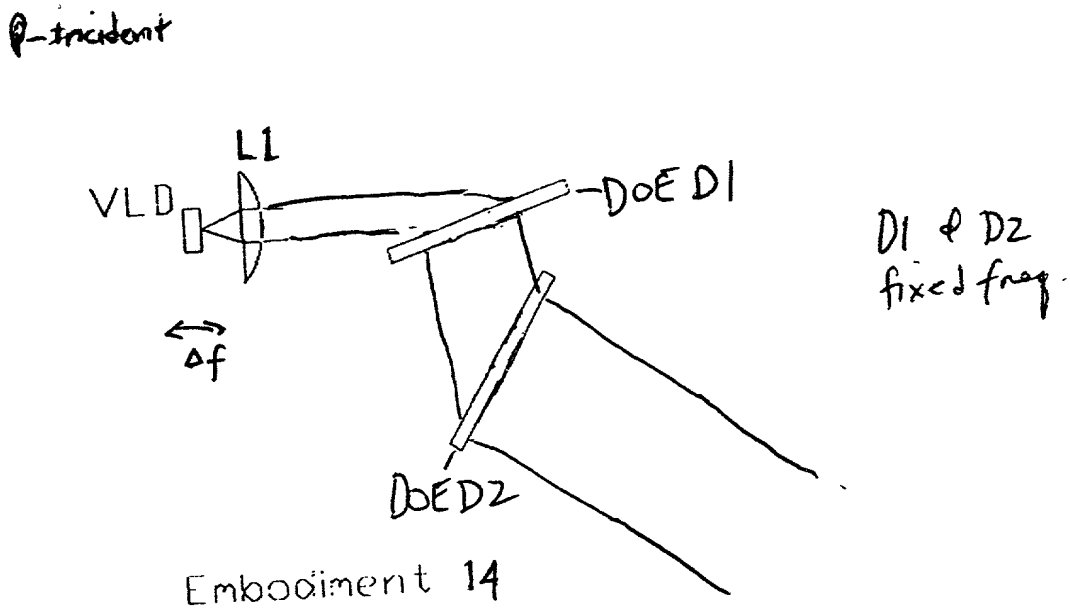


FIG. 2N

Document ID: US 9,885,459 B2

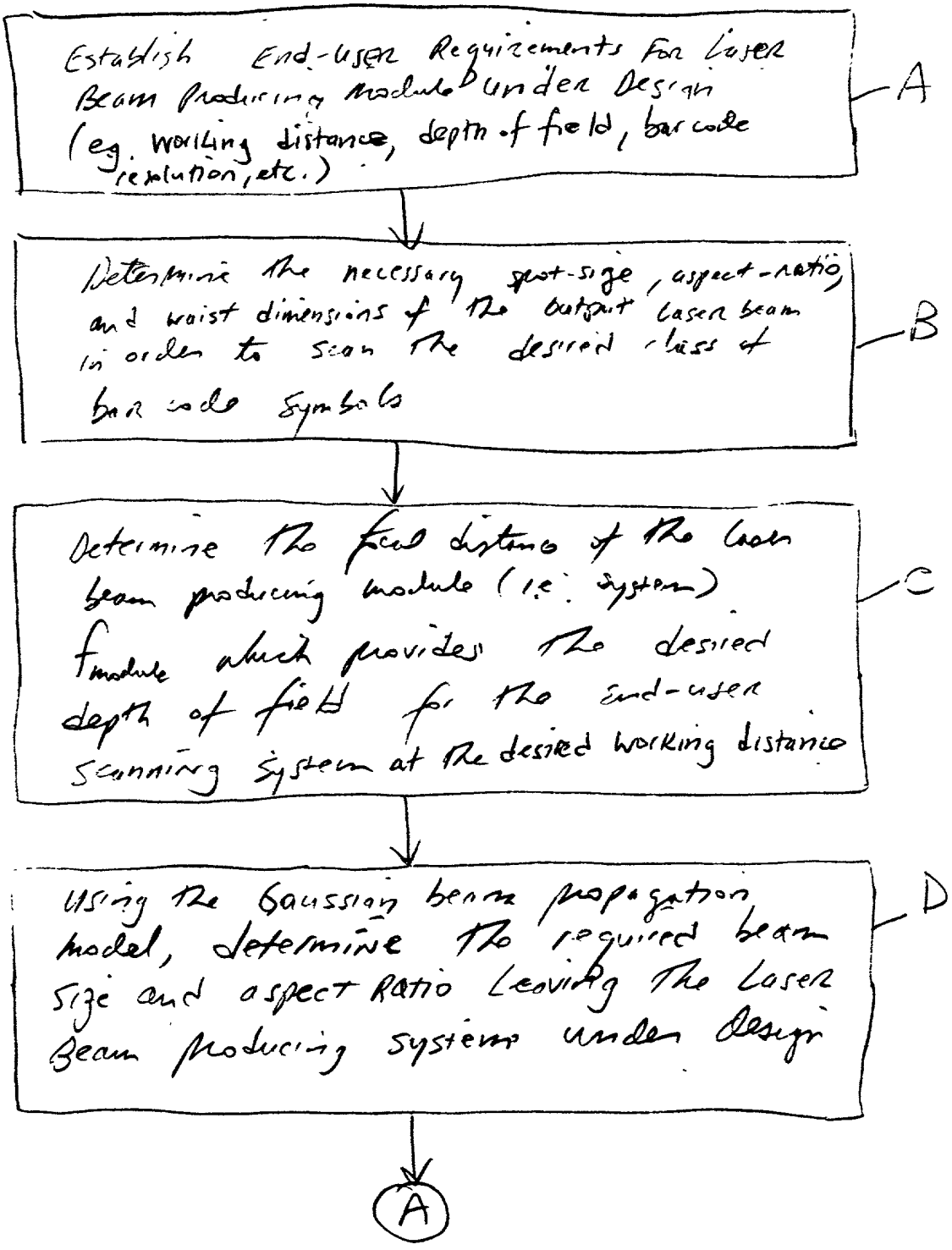

Establish End-User Requirements For Laser Beam producing module under design (eg. working distance, depth of field, bar code resolution, etc.)
A
Determine the necessary spot-size, aspect-ratio, and waist dimensions of the output laser beam in order to scan the desired class of bar code symbols
B
Determine the focal distance of the laser beam producing module (i.e. system) & module which provides the desired depth of field for the end-user scanning system at the desired working distance
C
Using the Gaussian beam propagation model, determine the required beam size and aspect ratio leaving the laser beam producing system under design
D
A

FIG. 3A1

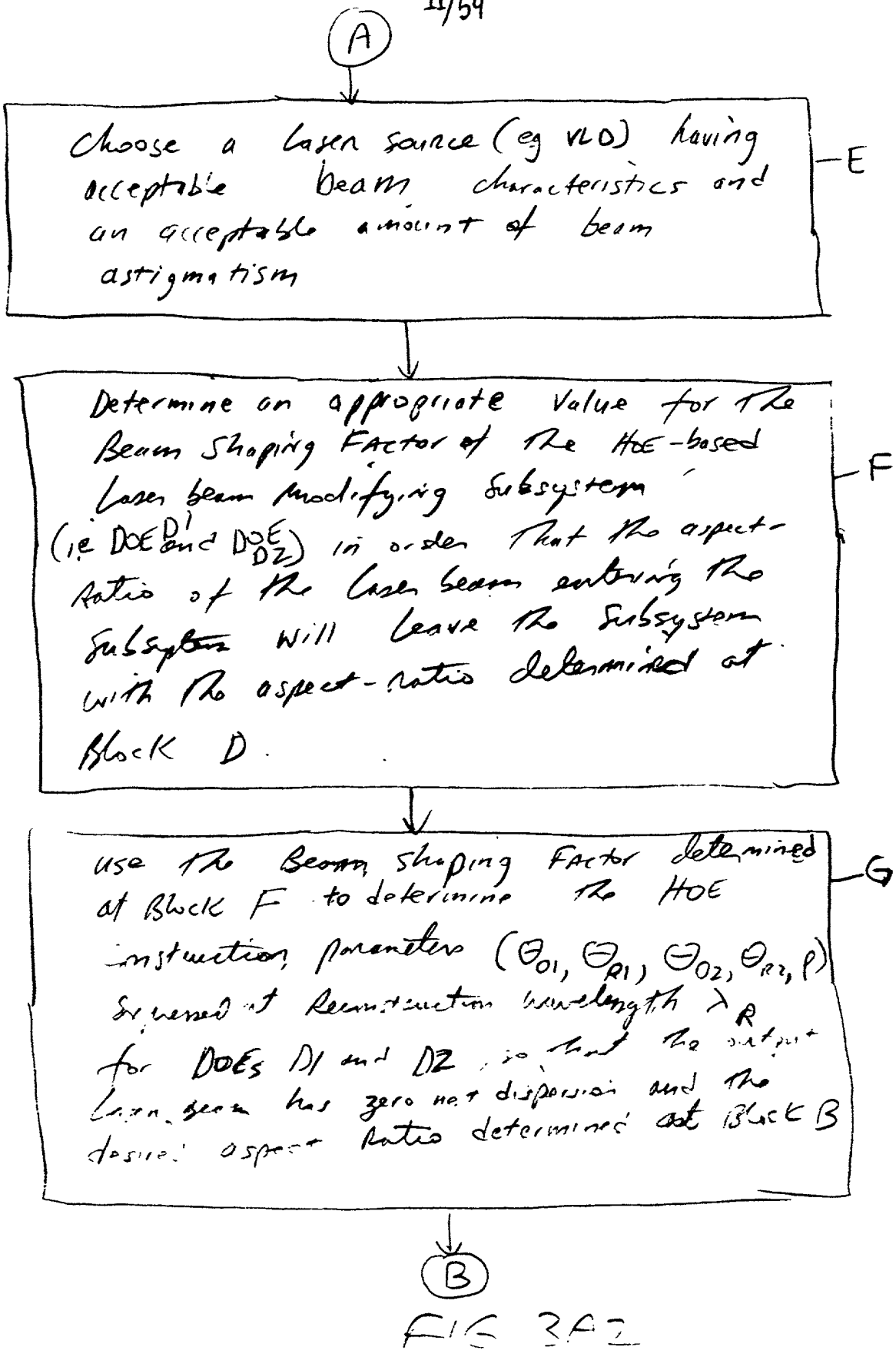

A
Choose a laser source (eg VLD) having acceptable beam characteristics and an acceptable amount of beam astigmatism
E
Determine an appropriate value for the Beam Shaping Factor of the HOE-based Laser beam modifying subsystem (ie DOE_{D1} and DOE_{D2}) in order that the aspect-ratio of the laser beam entering the subsystem will leave the subsystem with the aspect-ratio determined at Block D.
F
use the Beam shaping Factor determined at Block F to determine the HOE instruction parameters (Θ_{01}, Θ_{R1}) Θ_{02}, Θ_{R2}, ρ) designed at Reconstruction wavelength λ_R for DOEs D1 and D2, so that the output Laser beam has zero net dispersion and the desired aspect ratio determined at Block B
G
B

FIG 3A2

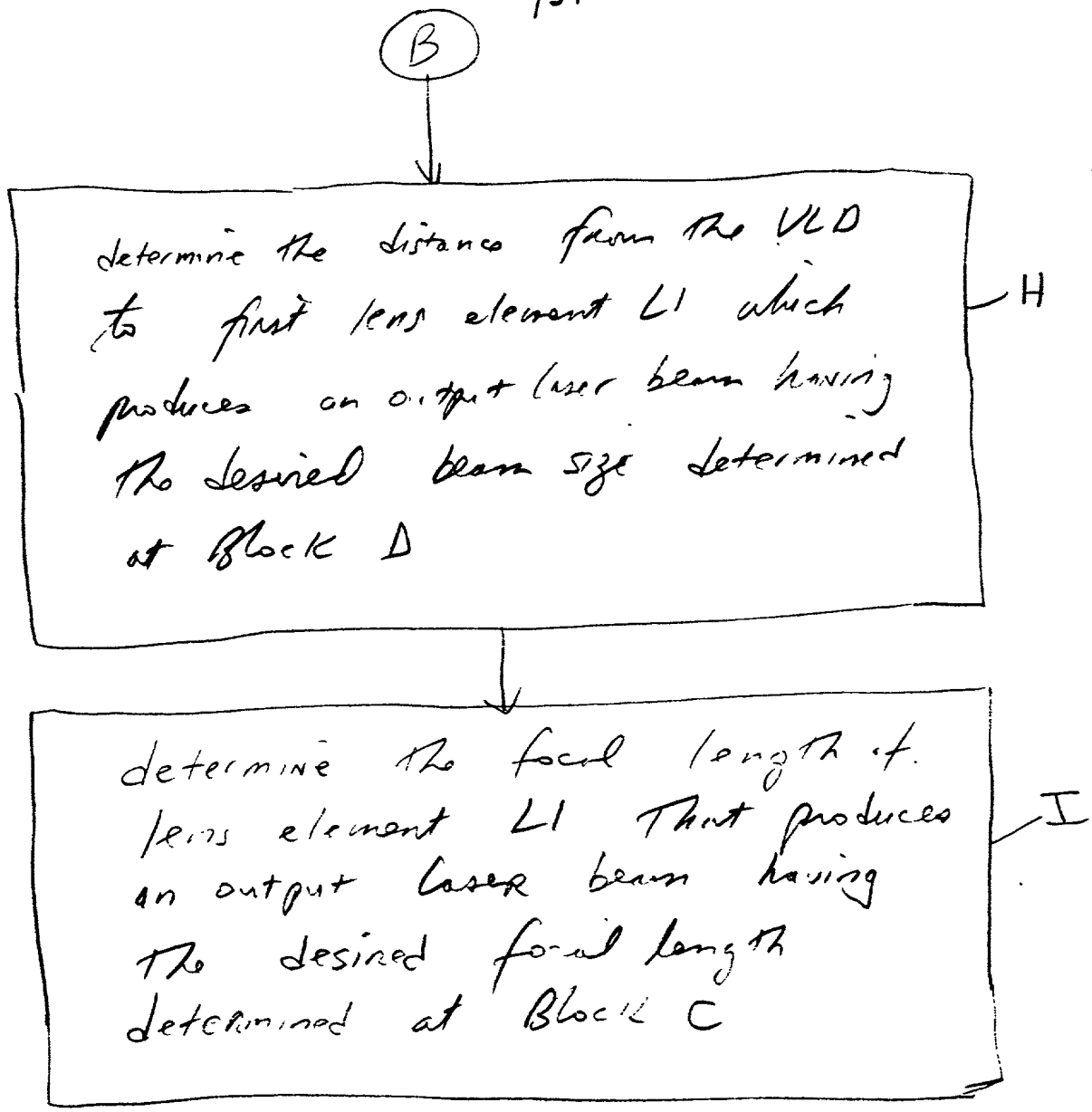

B
determine the distance from the VLD to first lens element L1 which produces an output laser beam having the desired beam size determined at Block D
H
determine the focal length of lens element L1 that produces an output laser beam having the desired focal length determined at Block C
I

FIG 3A3

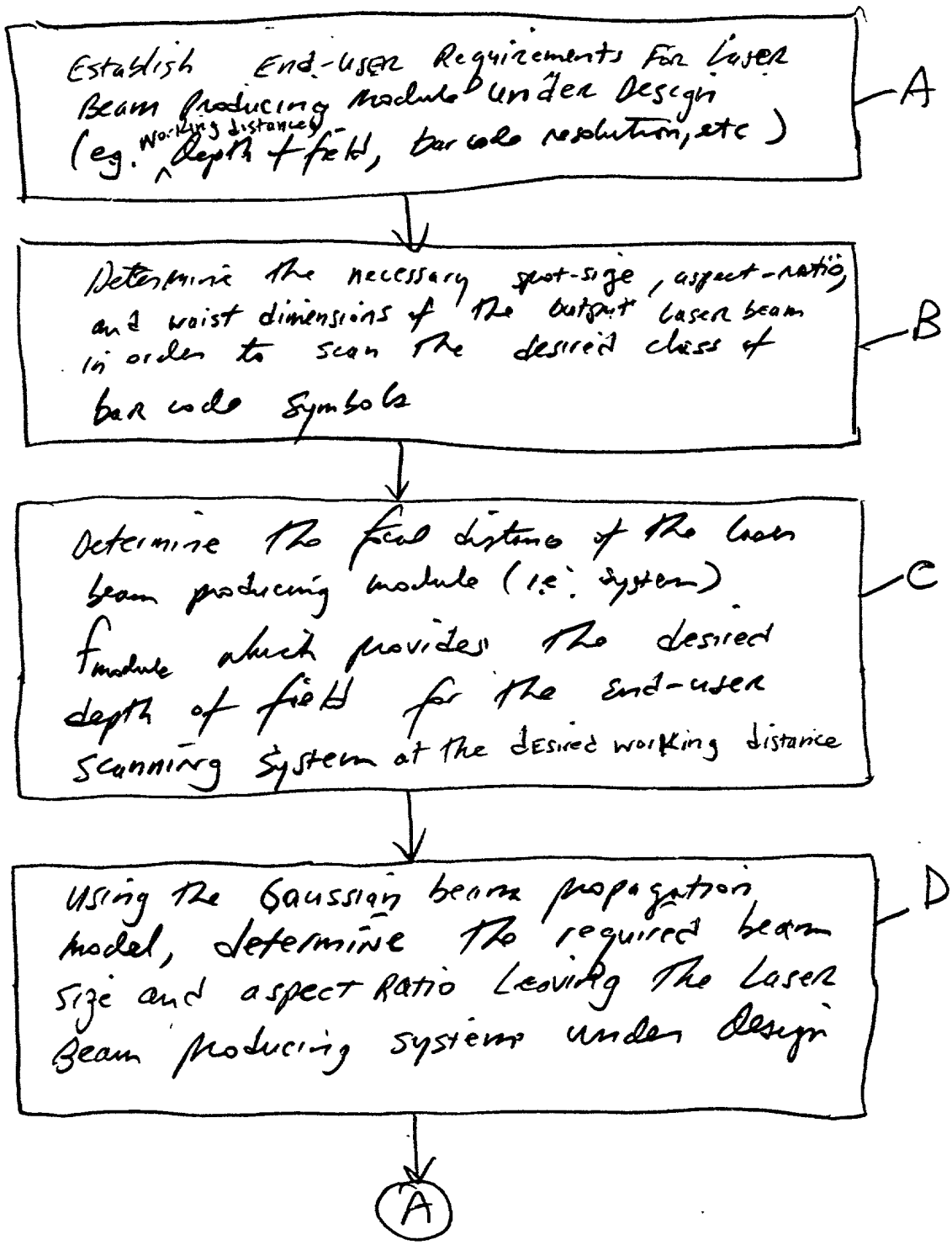

Establish End-User Requirements For Laser Beam producing module under design (eg. working distance, depth of field, bar code resolution, etc.)
A
Determine the necessary spot-size, aspect-ratio, and waist dimensions of the output laser beam in order to scan the desired class of bar code symbols
B
Determine the focal distance of the laser beam producing module (i.e. system) f module which provides the desired depth of field for the end-user scanning system at the desired working distance
C
Using the Gaussian beam propagation model, determine the required beam size and aspect ratio leaving the laser beam producing system under design
D
A

FIG. 3B1

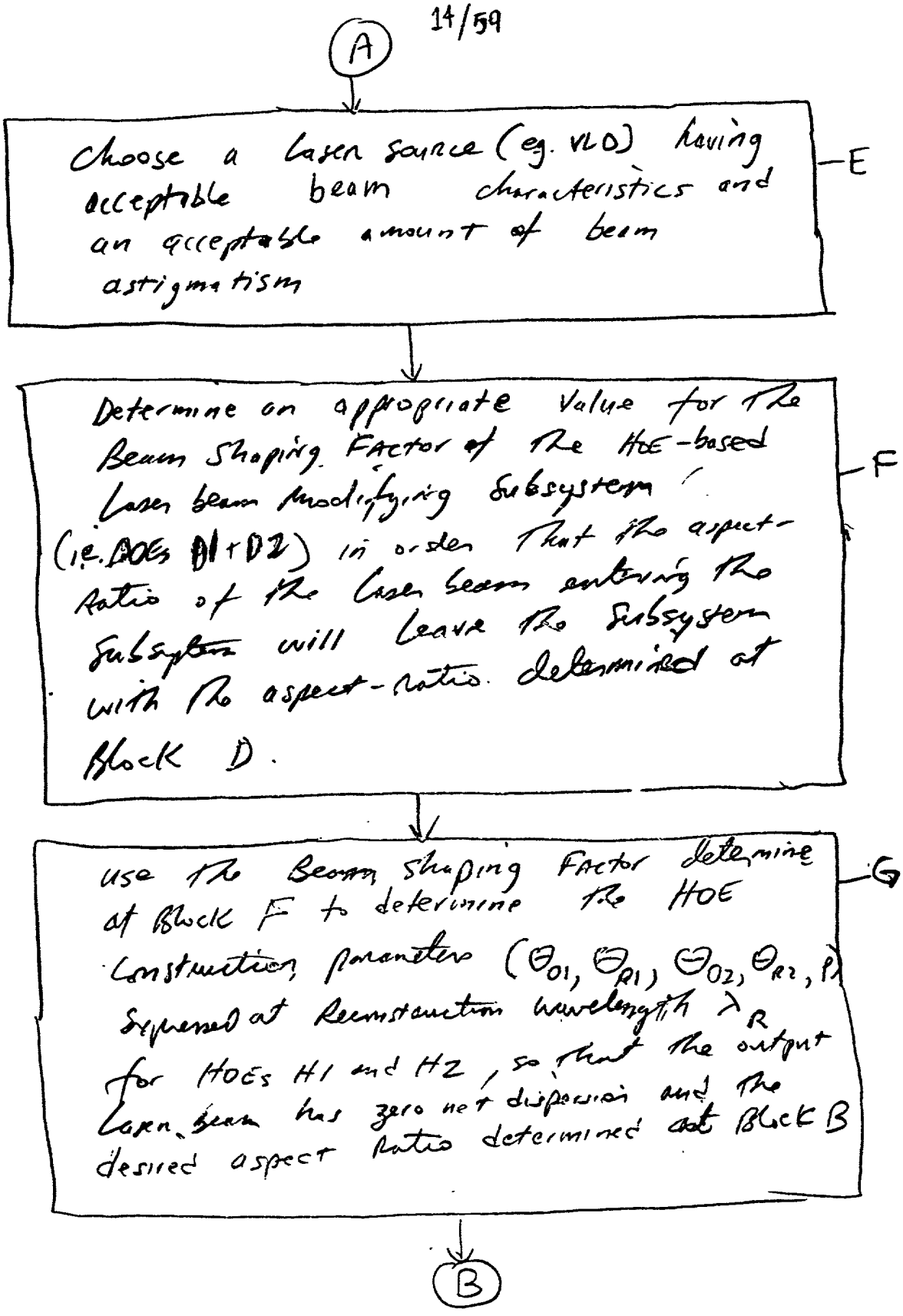

A
Choose a laser source (eg. VLD) having acceptable beam characteristics and an acceptable amount of beam astigmatism
E
Determine an appropriate value for the Beam Shaping Factor of the HOE-based Laser beam modifying subsystem (ie. HOEs H1 + H2) in order that the aspect-ratio of the Laser beam entering the Subsystem will leave the Subsystem with the aspect-ratio determined at Block D.
F
use the Beam shaping Factor determine at Block F to determine the HOE Construction parameters (Θ_{01}, Θ_{R1}, Θ_{02}, Θ_{R2}, R) Expressed at Reconstruction wavelength λ_R for HOEs H1 and H2, so that the output Laser beam has zero net dispersion and the desired aspect ratio determined at Block B
G
B

FIG 3B2

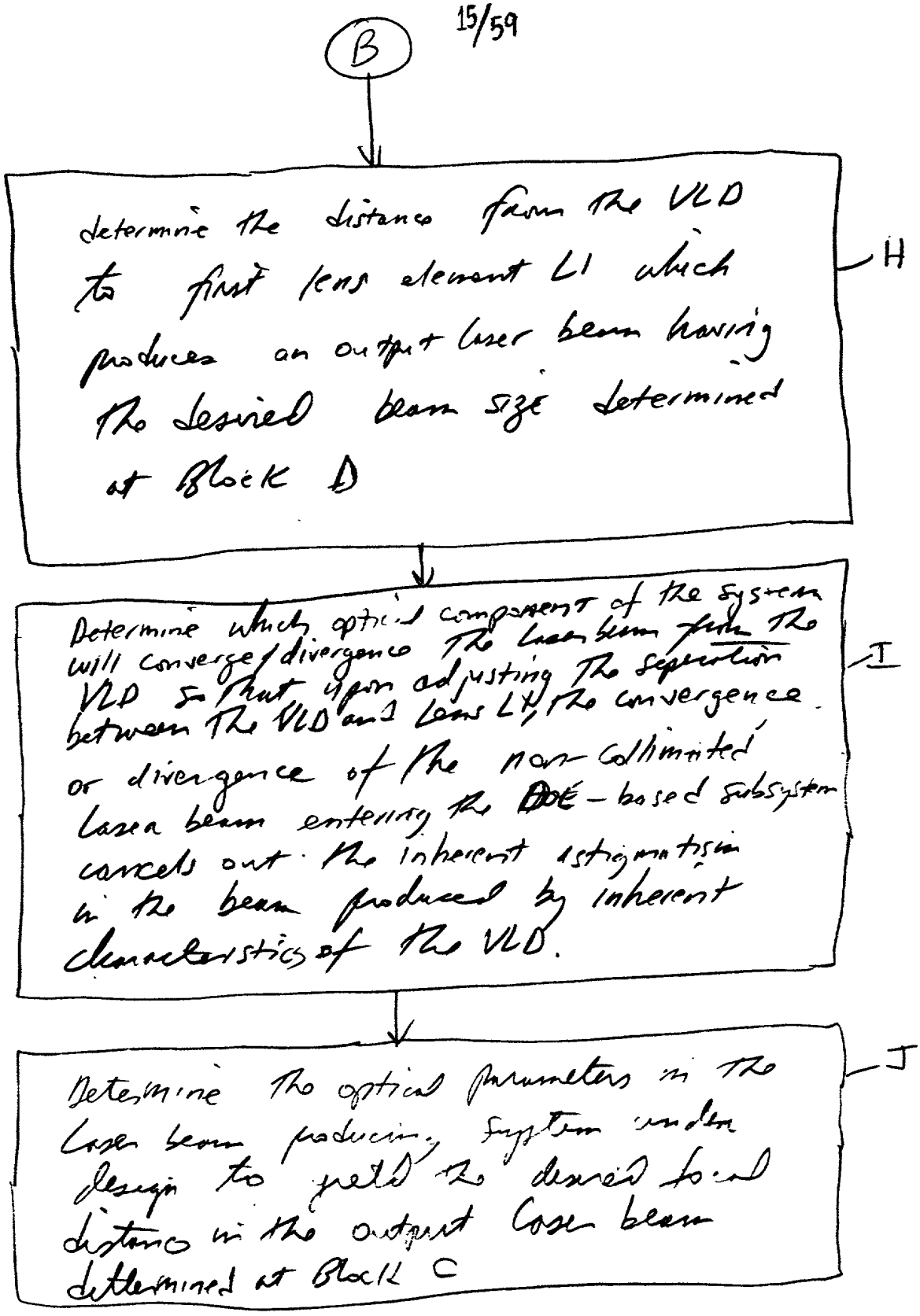

B
determine the distance from the VLD to first lens element L1 which produces an output laser beam having the desired beam size determined at Block D
H
Determine which optical component of the system will converge/divergence the laser beam from the VLD so that upon adjusting the separation between the VLD and lens L1, the convergence or divergence of the non-collimated laser beam entering the DOE-based subsystem cancels out the inherent astigmatism in the beam produced by inherent characteristics of the VLD.
I
Determine the optical parameters in the laser beam producing system under design to yield the desired focal distance in the output laser beam determined at Block C
J

FIG. 3B3

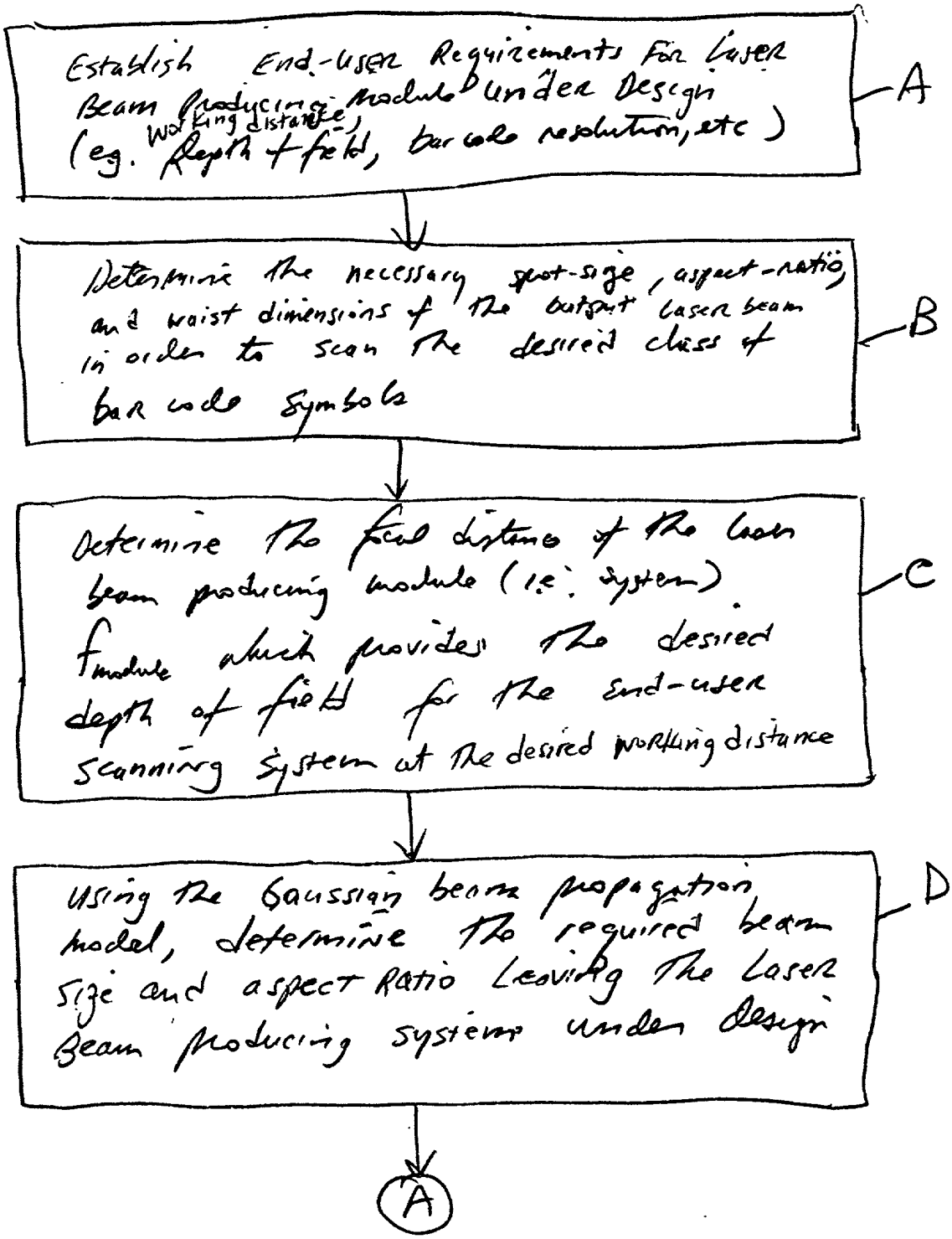


FIG. 3C1

05965423-082704

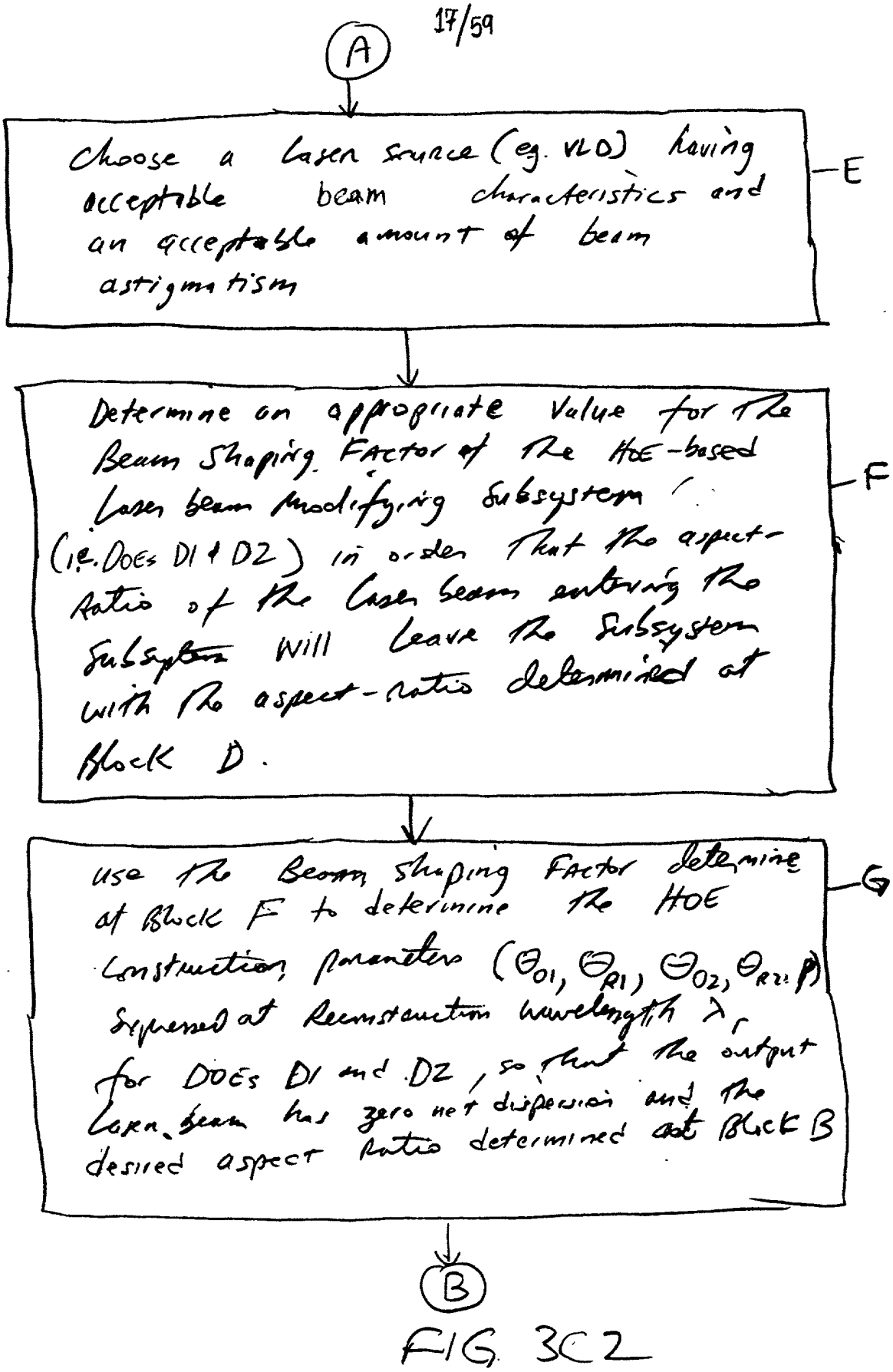


FIG. 3C2

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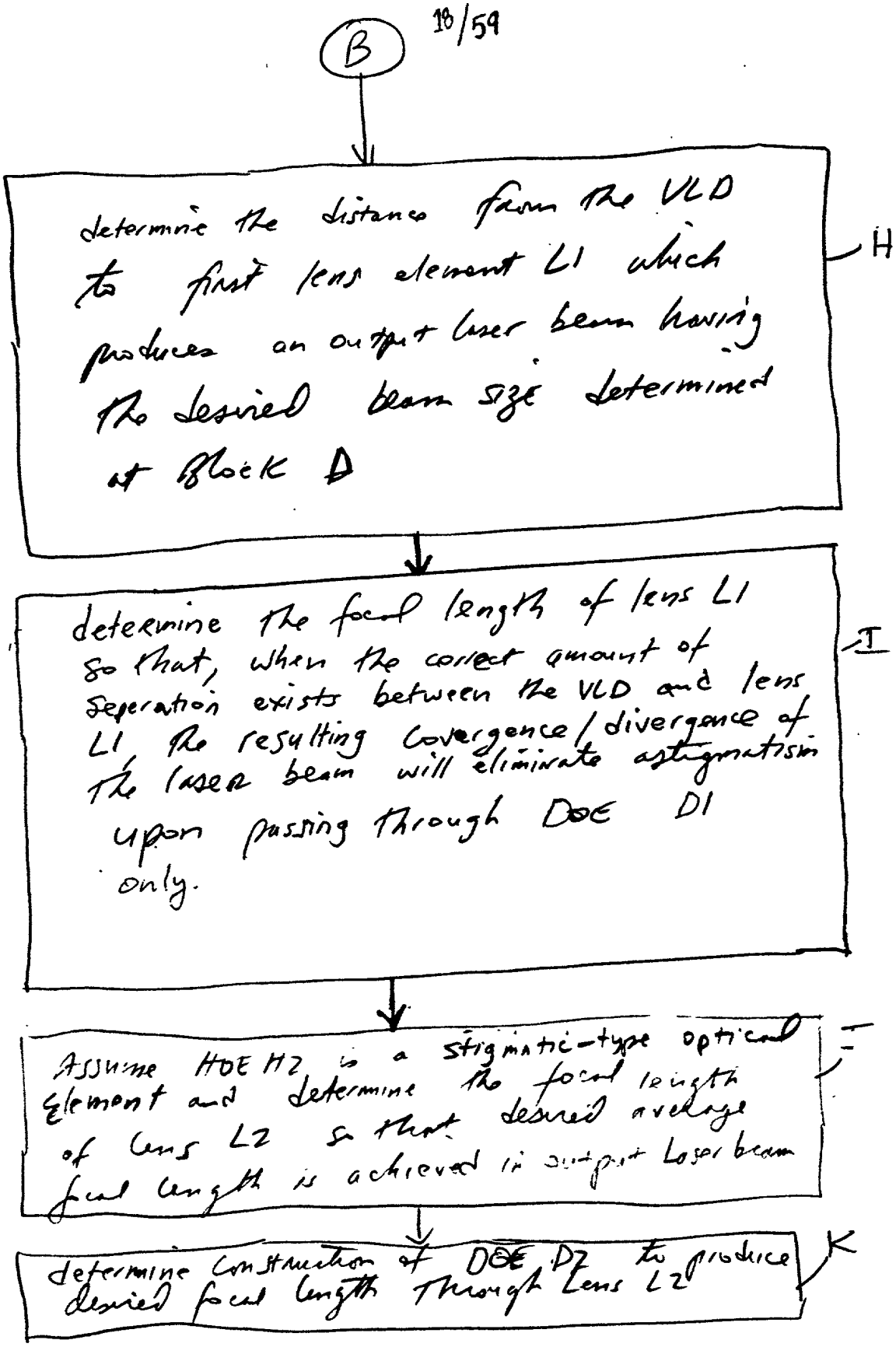


FIG 3C3

0960423-092704

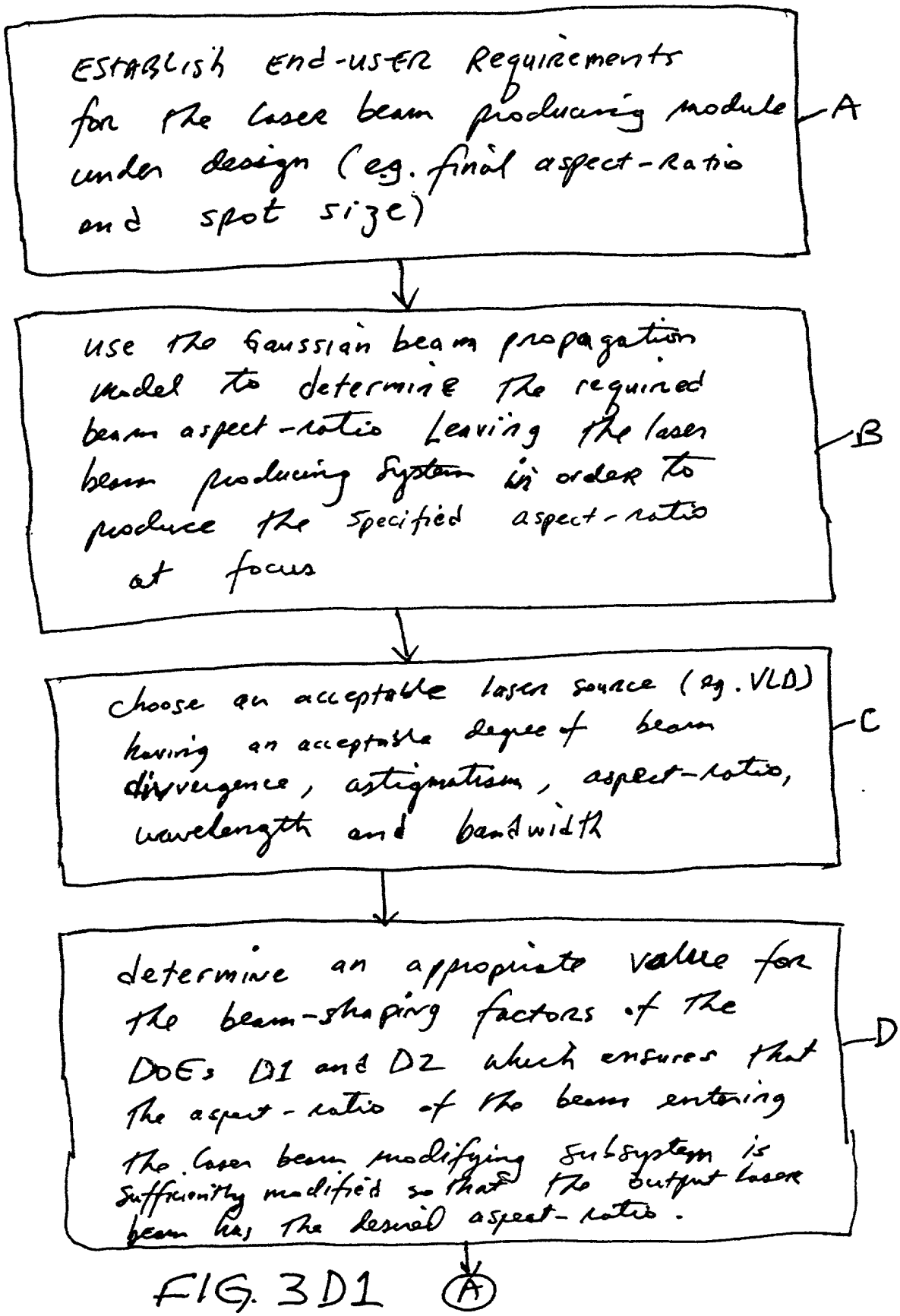
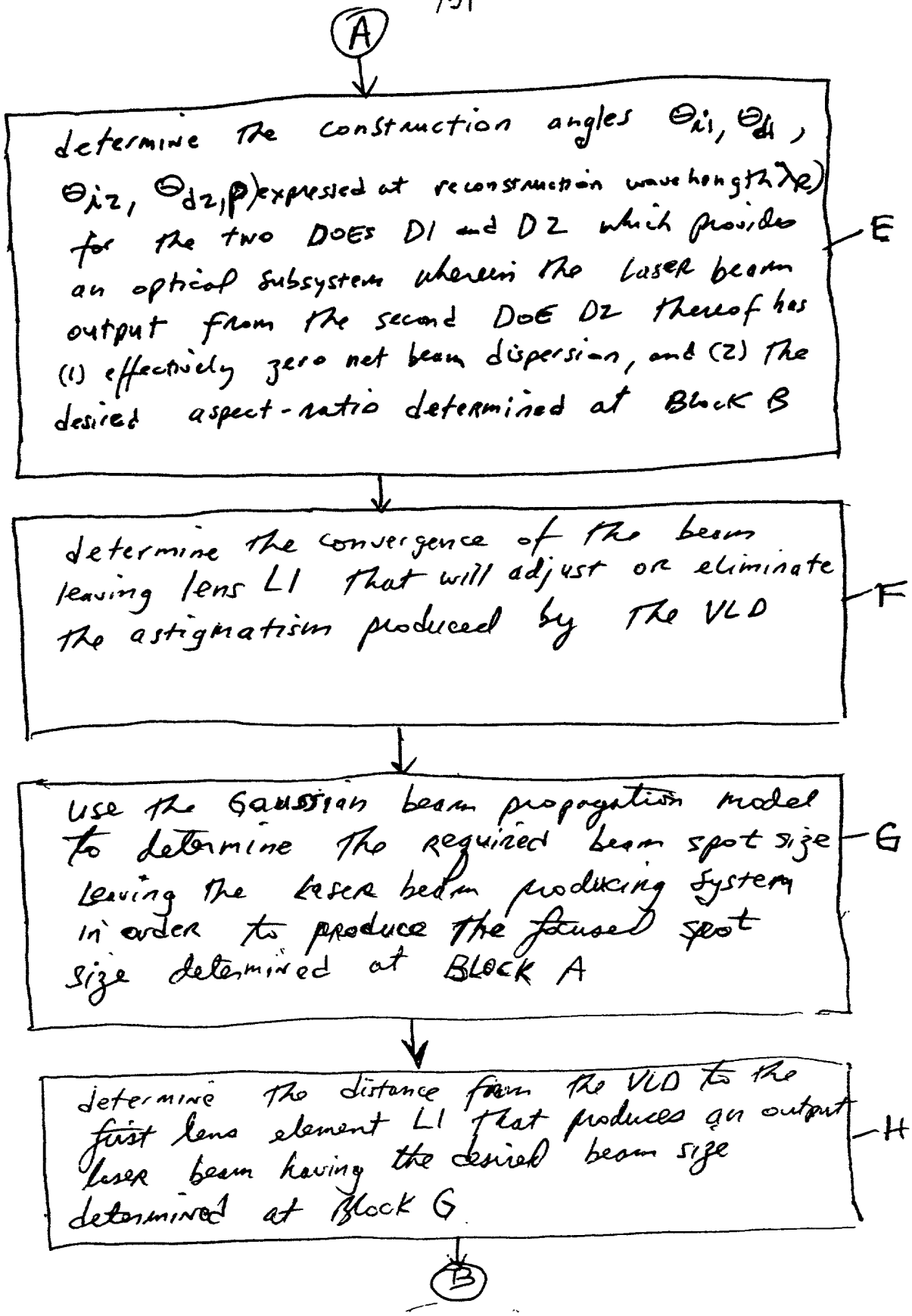

ESTABLISH end-USER Requirements for the laser beam producing module under design (eg. final aspect-ratio and spot size)
A
use the Gaussian beam propagation model to determine the required beam aspect-ratio leaving the laser beam producing system in order to produce the specified aspect-ratio at focus
B
choose an acceptable laser source (eg. VLD) having an acceptable degree of beam divergence, astigmatism, aspect-ratio, wavelength and bandwidth
C
determine an appropriate value for the beam-shaping factors of the DOEs D1 and D2 which ensures that the aspect-ratio of the beam entering the laser beam modifying subsystem is sufficiently modified so that the output laser beam has the desired aspect-ratio.
D
A

FIG. 3D1


A
determine the construction angles $\Theta_{\lambda 1}$, Θ_{d1}, $\Theta_{\lambda 2}$, $\Theta_{d2,\beta}$ expressed at reconstruction wavelength (λ_R) for the two DOEs D1 and D2 which provides an optical subsystem wherein the laser beam output from the second DOE D2 thereof has (1) effectively zero net beam dispersion, and (2) the desired aspect-ratio determined at Block B
E
determine the convergence of the beam leaving lens L1 that will adjust or eliminate the astigmatism produced by the VLD
F
use the Gaussian beam propagation model to determine the required beam spot size leaving the laser beam producing system in order to produce the focused spot size determined at BLOCK A
G
determine the distance from the VLD to the first lens element L1 that produces an output laser beam having the desired beam size determined at Block G
H
B

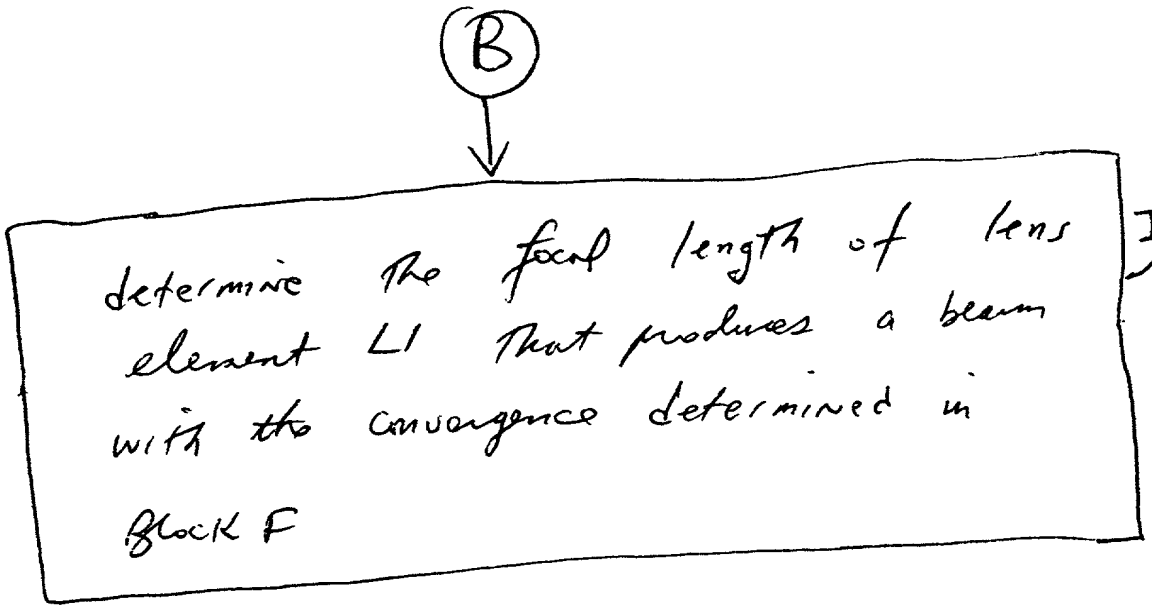


FIG 3D3

09656243 - 092704

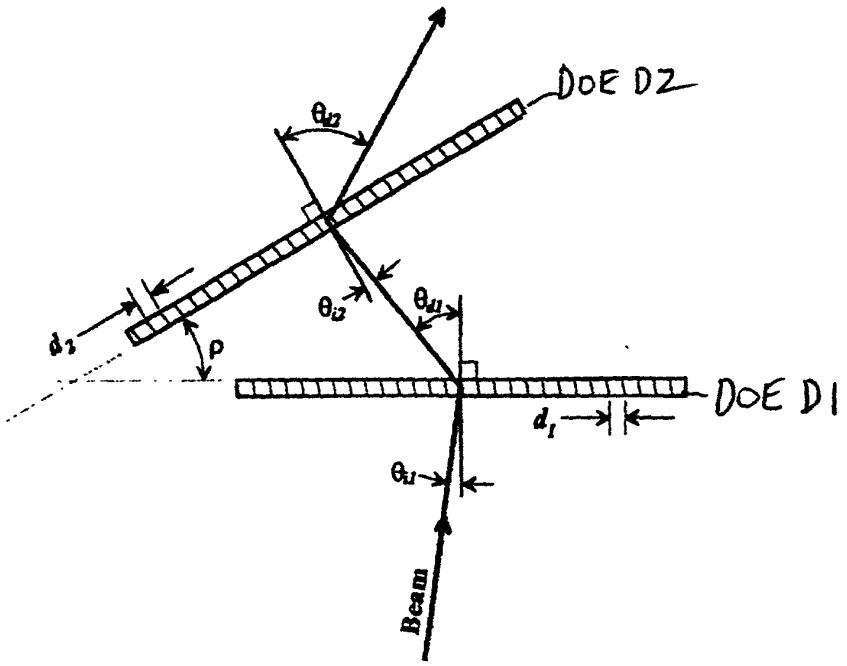


FIG. 3E

SUBSTITUTE SHEET (RULE 26)

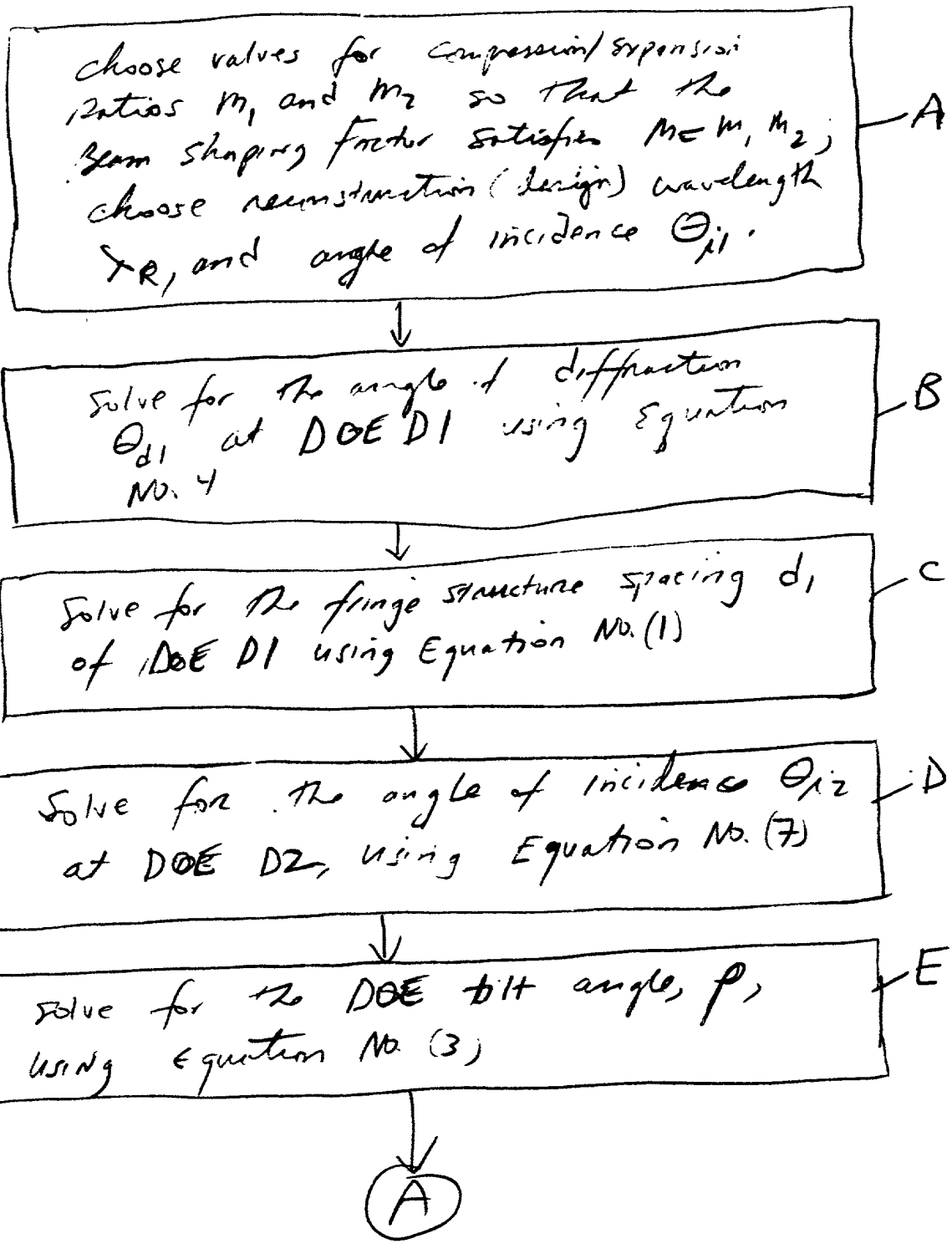

Choose values for compression/expansion ratios m_1 and m_2 so that the beam shaping factor satisfies $M = m_1 m_2$, choose reconstruction (design) wavelength λ_R, and angle of incidence θ_{i1}.
A
Solve for the angle of diffraction θ_{d1} at DOE D1 using Equation No. 4
B
Solve for the fringe structure spacing d_1 of DOE D1 using Equation No. (1)
C
Solve for the angle of incidence θ_{i2} at DOE D2, using Equation No. (7)
D
Solve for the DOE tilt angle, ρ, using equation No. (3)
E
A

FIG 3F1

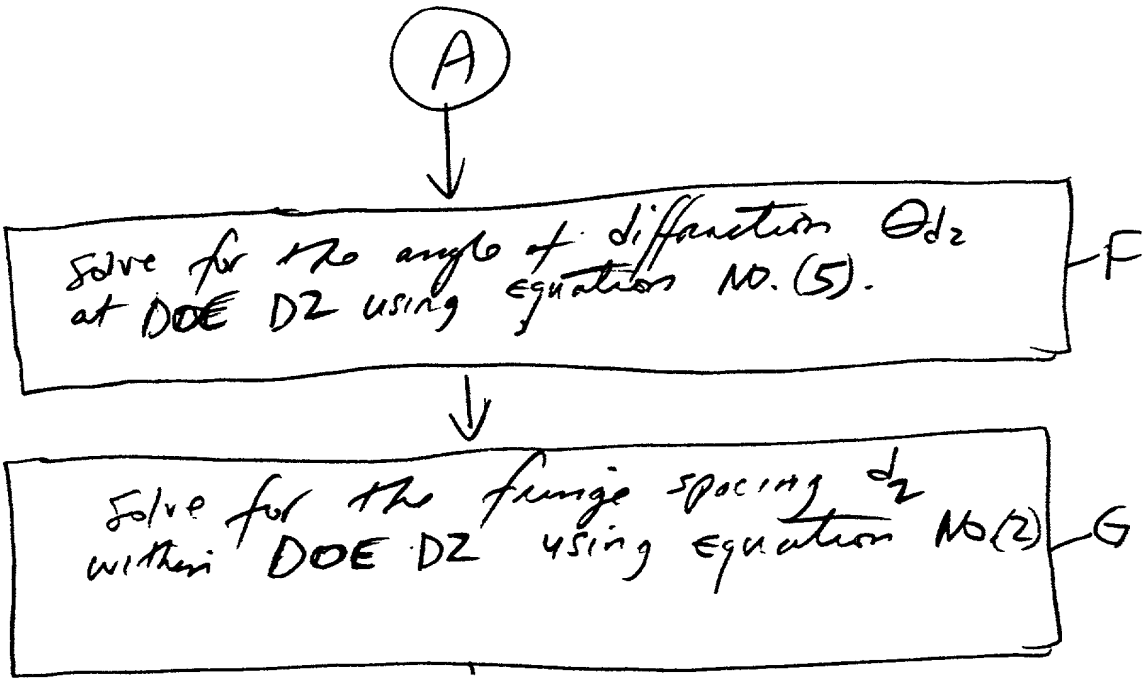

A
Solve for the angle of diffraction θ_{d_2} at DOE D2 using equation NO. (5).
F
Solve for the fringe spacing d_2 within DOE D2 using equation NO(2)
G

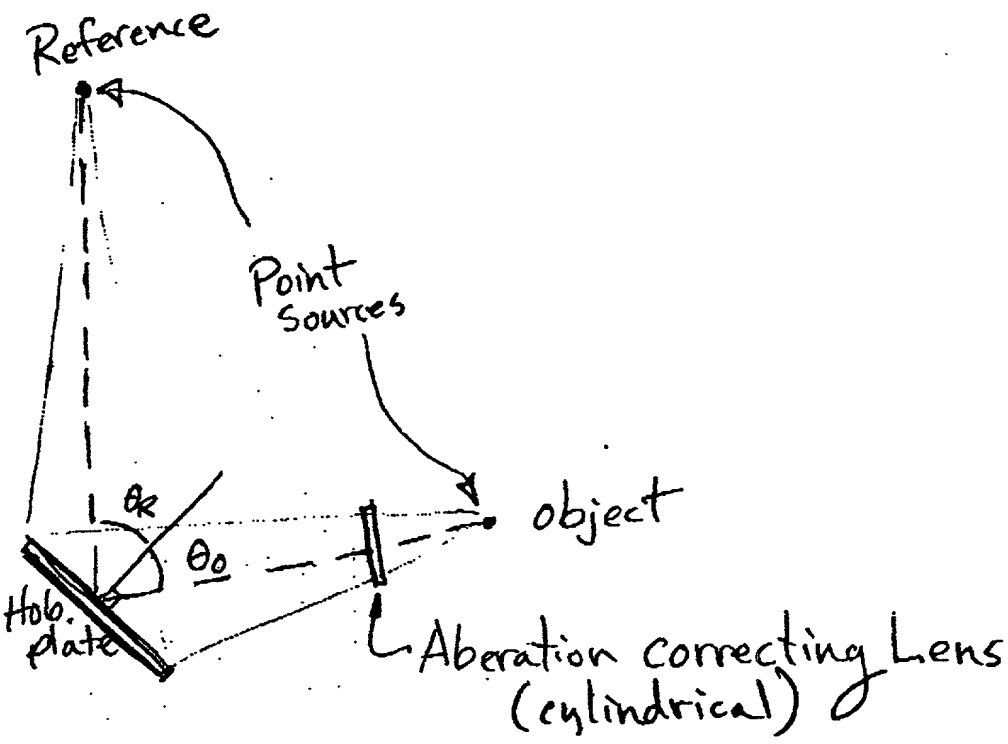
FIG. 3F2

A ~ Convert the design parameters $\Theta_{i1}, \Theta_{d1}, \Theta_{i2}, \Theta_{d2}$, (and f_2) expressed at the reconstruction wavelength λ_R into construction parameters expressed at the construction wavelength λ_C, namely: Θ_{01}, Θ_{R1} for HOE H1; and Θ_{02}, Θ_{R2} for HOE H2

B ~ In the case of variable spatial frequency DOES, use computer-ray tracing to determine the distances of the object and reference (beam) sources relative to the holographic recording medium (as well as the distances of any aberration-correcting lenses therefrom) employed during the holographic recording process

FIG 4A

95695.122 - 09/27/04



θ_o = OBJECT BEAM ANGLE OF INCIDENCE

θ_r = REFERENCE BEAM ANGLE OF INCIDENCE

FIG. 4B

09654282 - 062298

formulate within a digital computer system, a mathematical description of the object and reference beam wavefronts used to construct DOE D1 and DOE D2, during optical formation thereof when using the Holographic Recording method shown in Fig. 4B — A

Use the digital computer system to formulate a mathematical description of the interference pattern that is generated by mathematically adding the mathematical model of the object beam wavefront to the reference beam wavefront, to provide a spatial function of the computer generated/represented interference pattern — B

Use the digital computer system to sample the spatial function of the computer generated/represented interference pattern along the x and y directions thereof to produce a large set of sampled values of varying amplitude transmittance associated with the computer generated interference pattern — C

(A)

FIG. 4C1

09/05/2003, 09/27/04

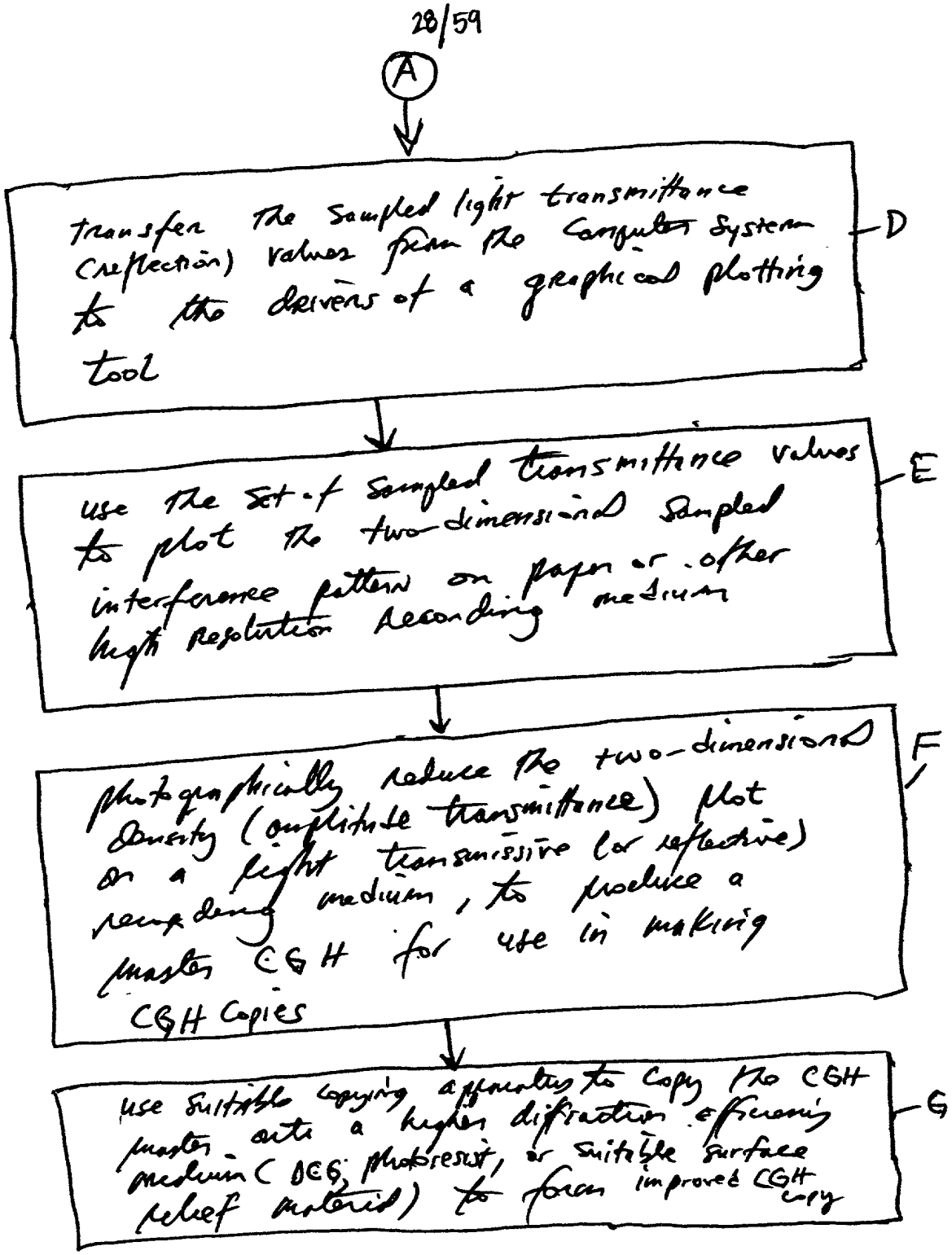


FIG. 4C2

09655422 - 092504

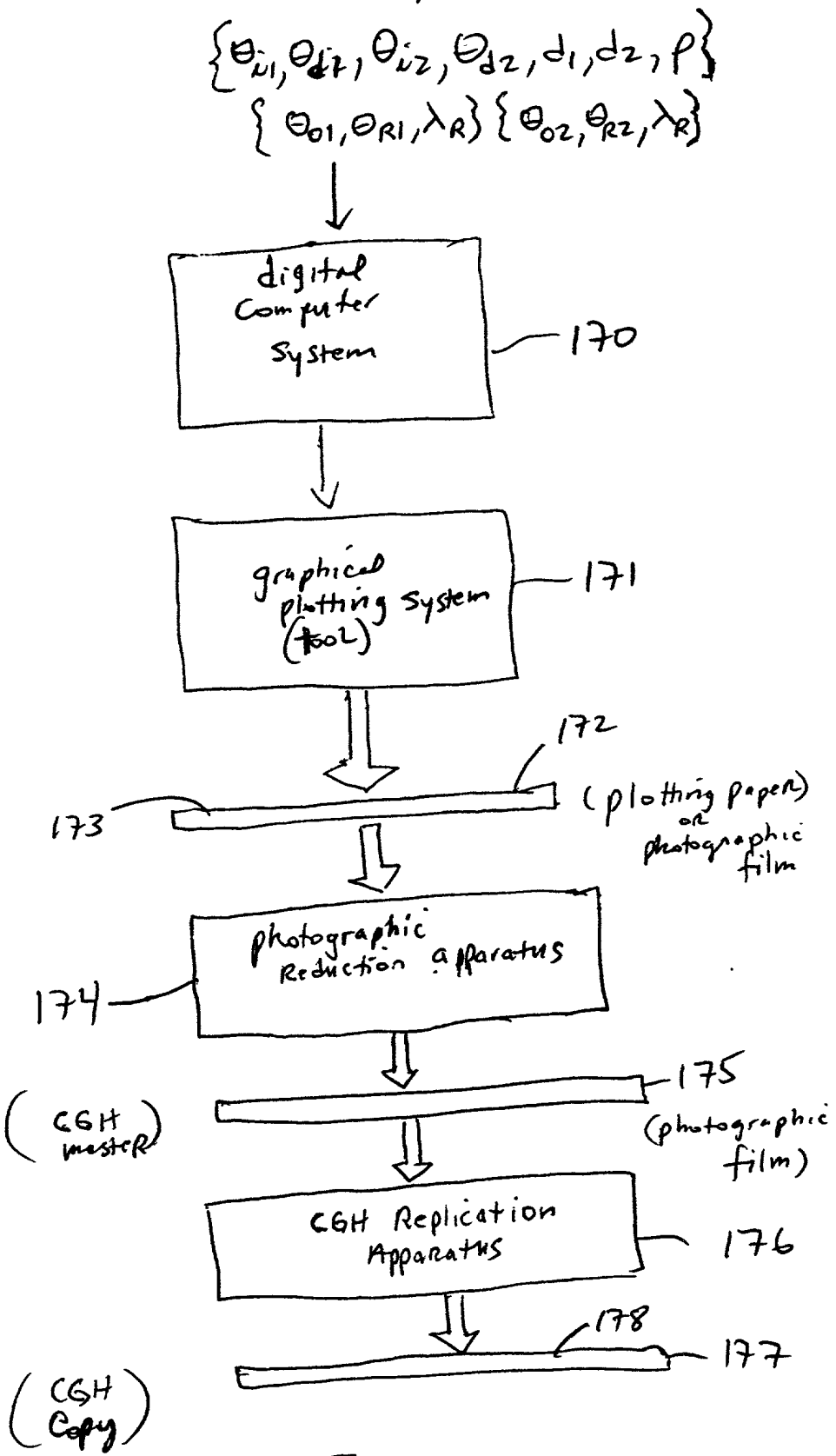

$\{\theta_{i1}, \theta_{d1}, \theta_{i2}, \theta_{d2}, d_1, d_2, \rho\}$
$\{\theta_{01}, \theta_{R1}, \lambda_R\}$ $\{\theta_{02}, \theta_{R2}, \lambda_R\}$
digital Computer System
170
graphical plotting System (tool)
171
172
173
(plotting paper) or photographic film
photographic Reduction apparatus
174
175
(CGH master)
(photographic film)
CGH Replication Apparatus
176
178
177
(CGH Copy)

FIG 4D

PCT/US98/23950

Beam Dispersion Analysis

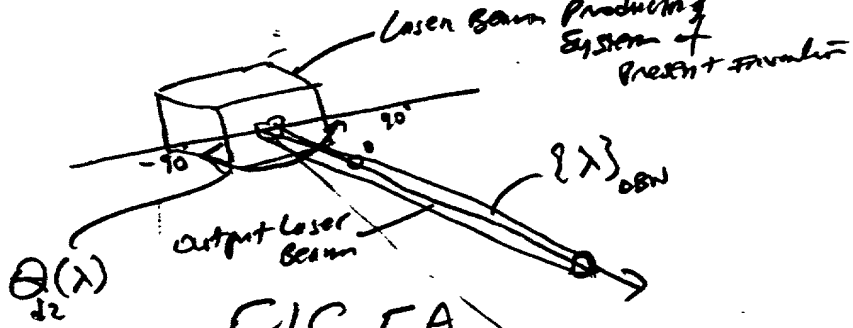


FIG. 5A

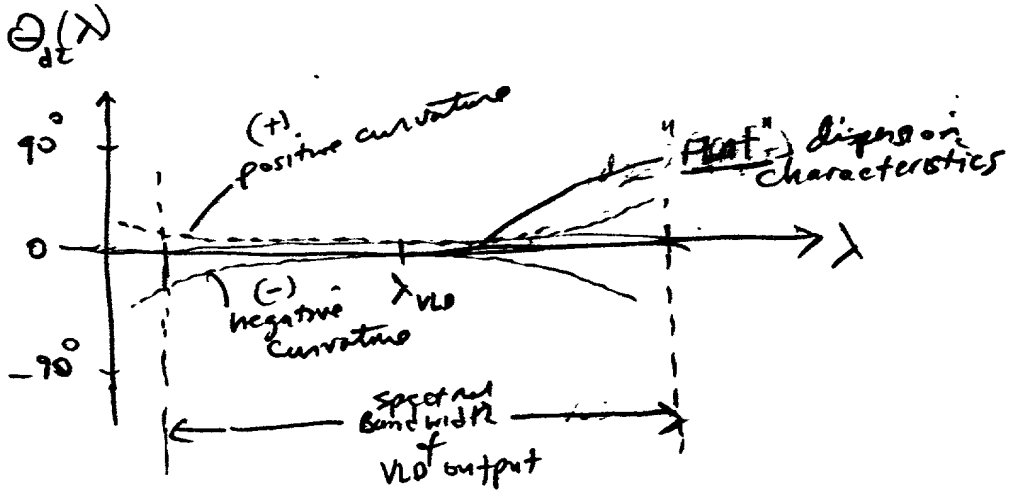


FIG. 5B

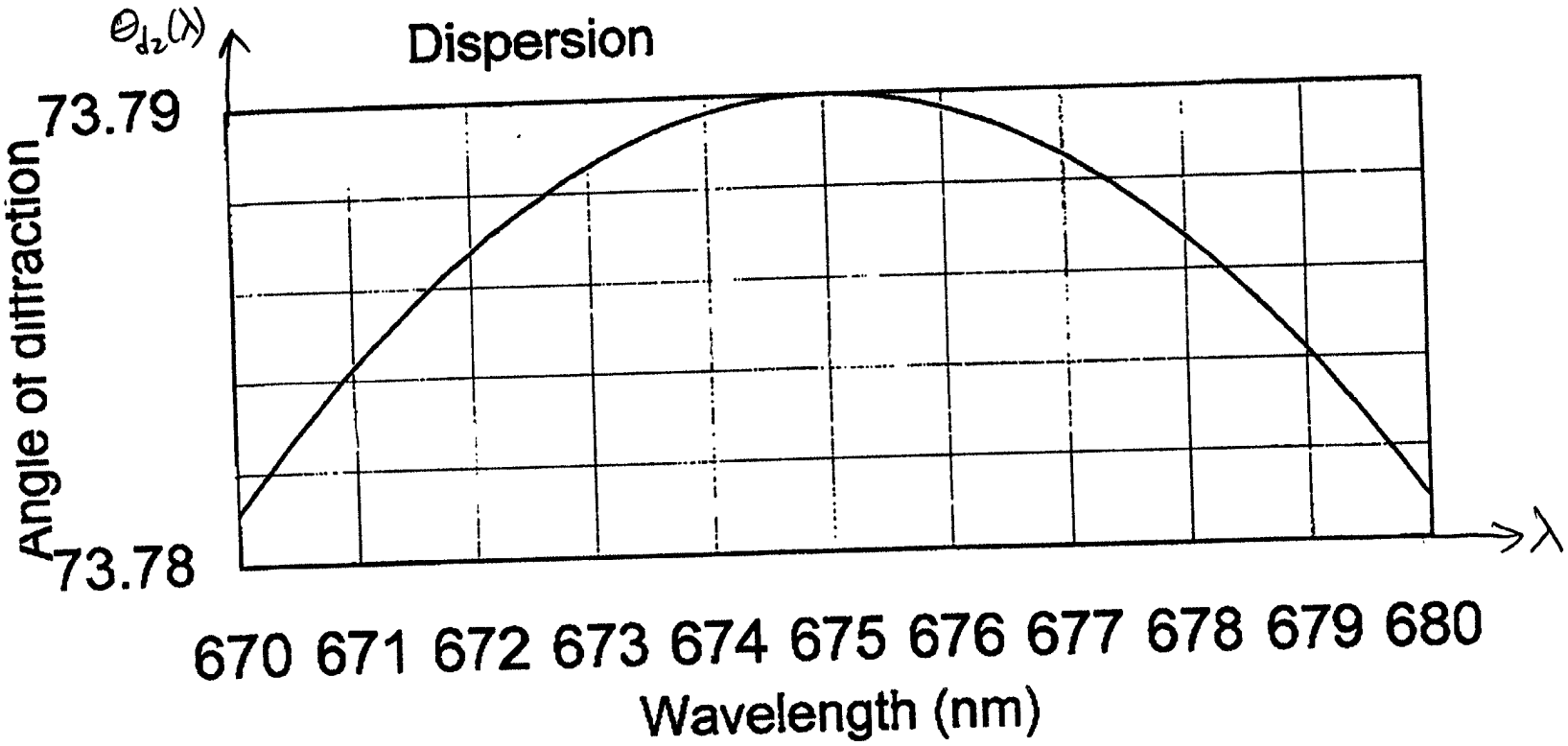

$\theta_{dz}(\lambda)$
Dispersion
73.79
73.78
Angle of diffraction
λ
670 671 672 673 674 675 676 677 678 679 680
Wavelength (nm)

FIG 5B1

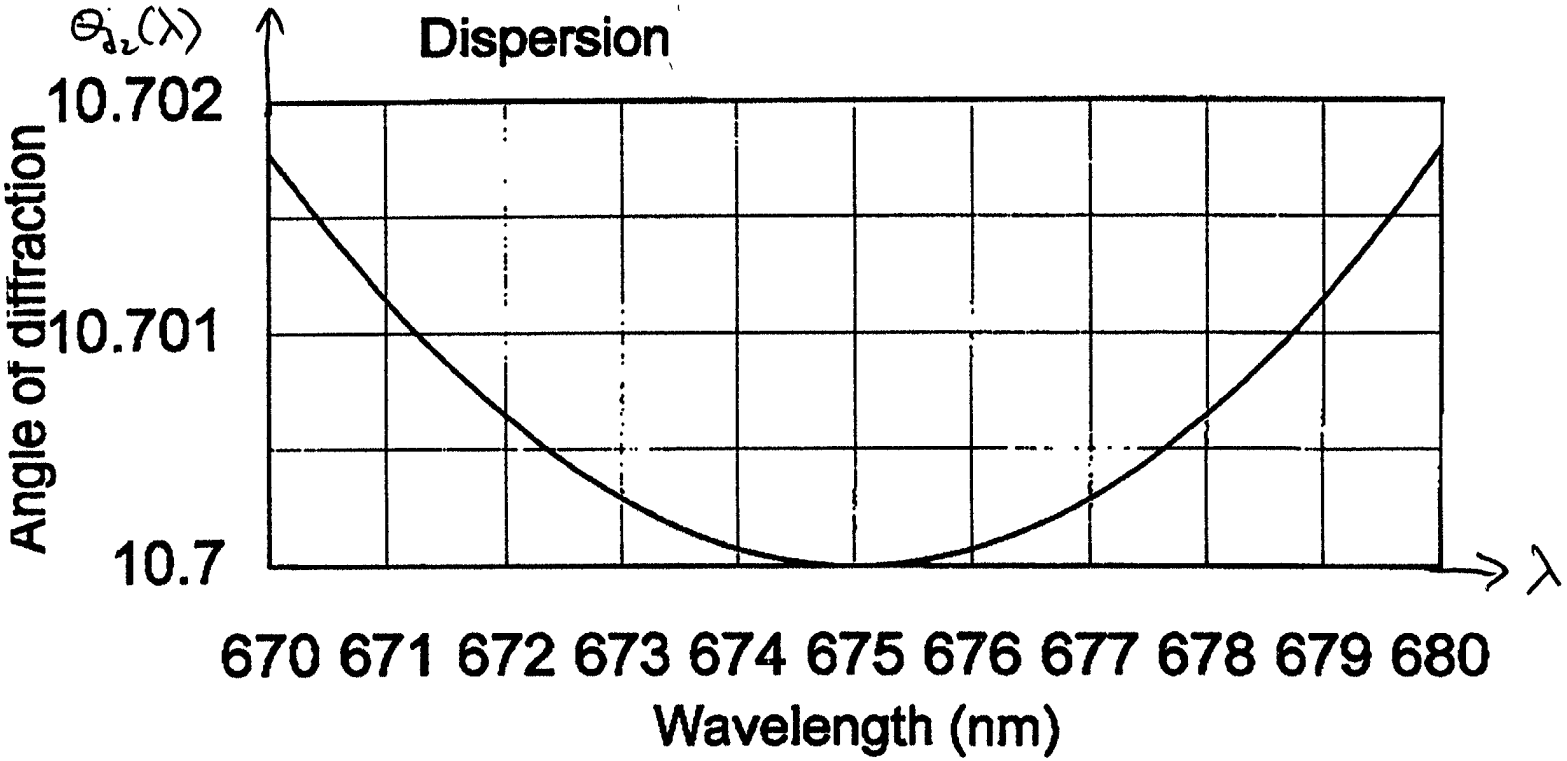

$\Theta_{d2}(\lambda)$
Dispersion
10.702
10.701
10.7
Angle of diffraction
λ
670 671 672 673 674 675 676 677 678 679 680
Wavelength (nm)

FIG 5B2

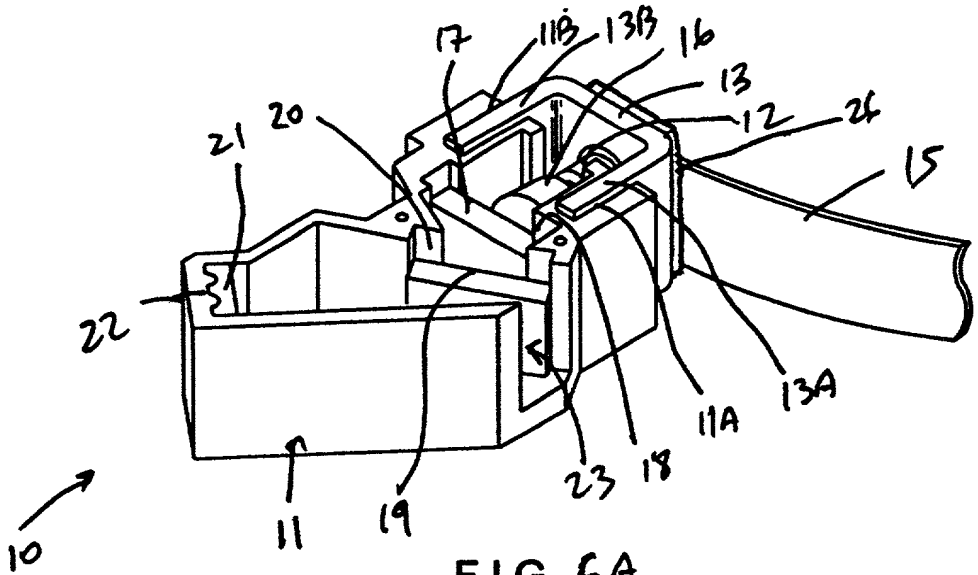


FIG. 6A

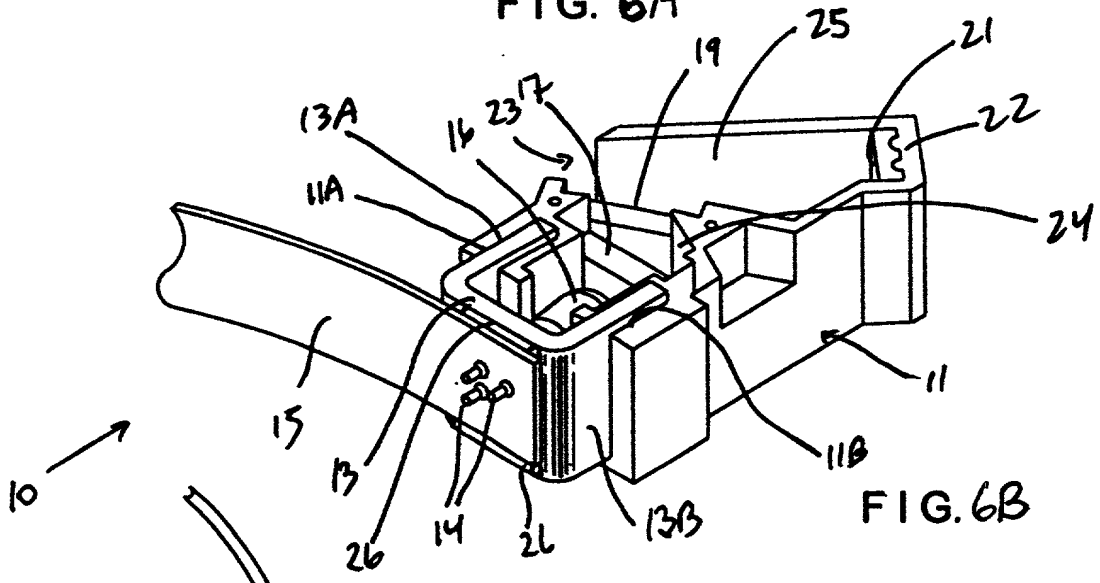


FIG. 6B

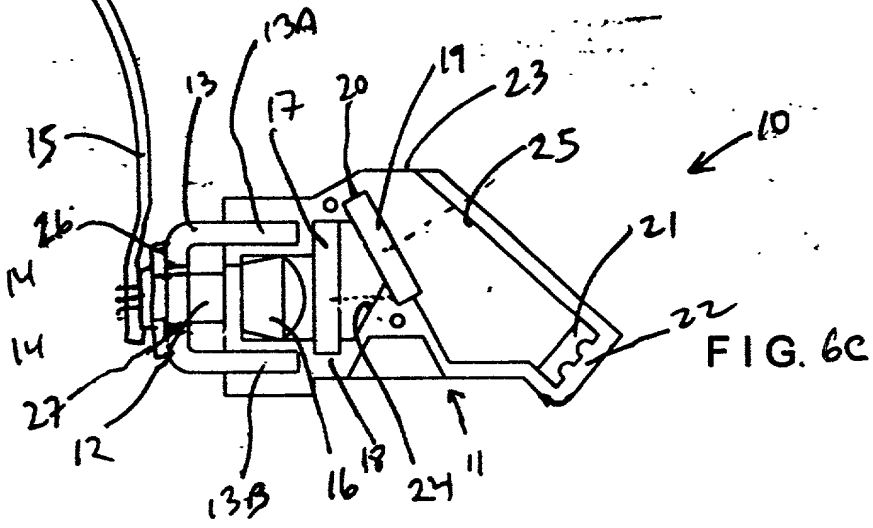


FIG. 6C

09656253 - 062704

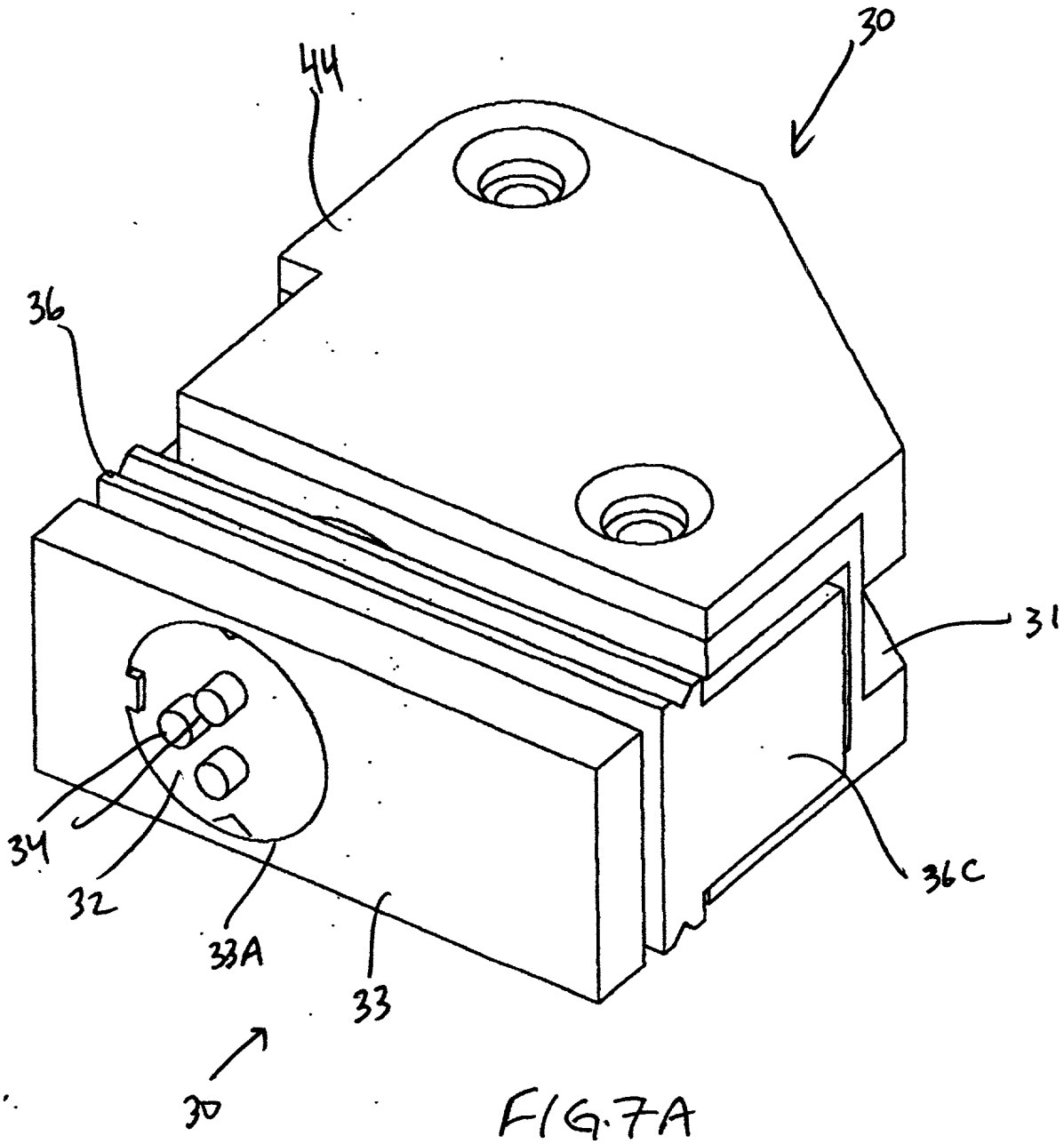


FIG.7A

US 2015/0265350 A1

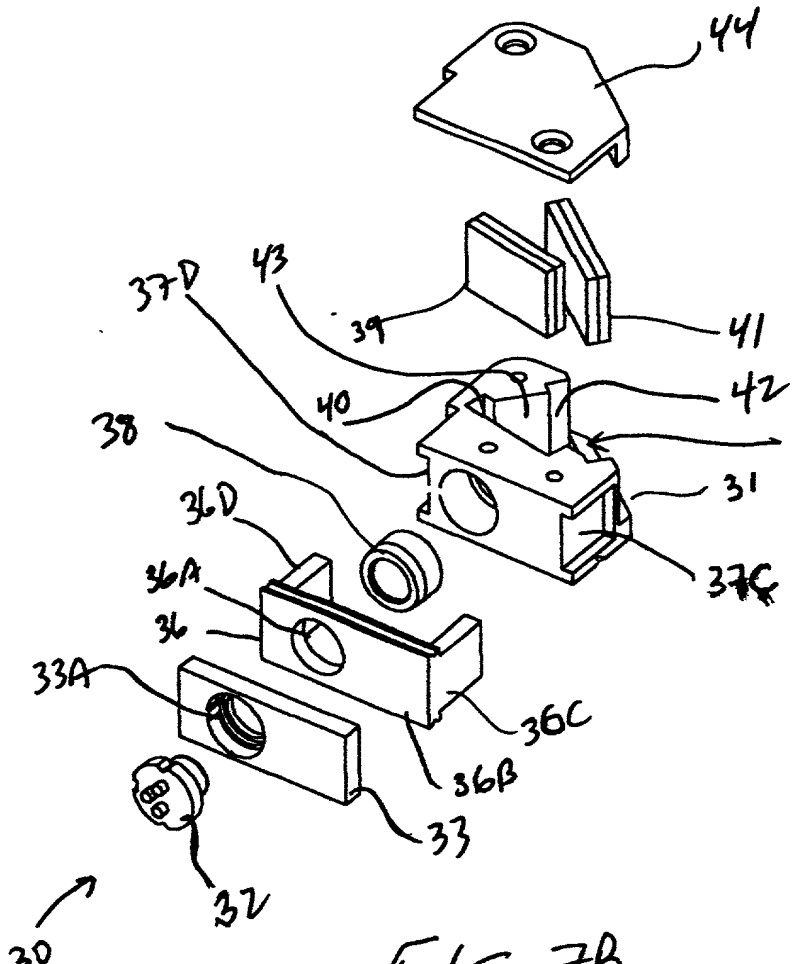


FIG. 7B

WO 2021/158552 PCT/US2021/016552

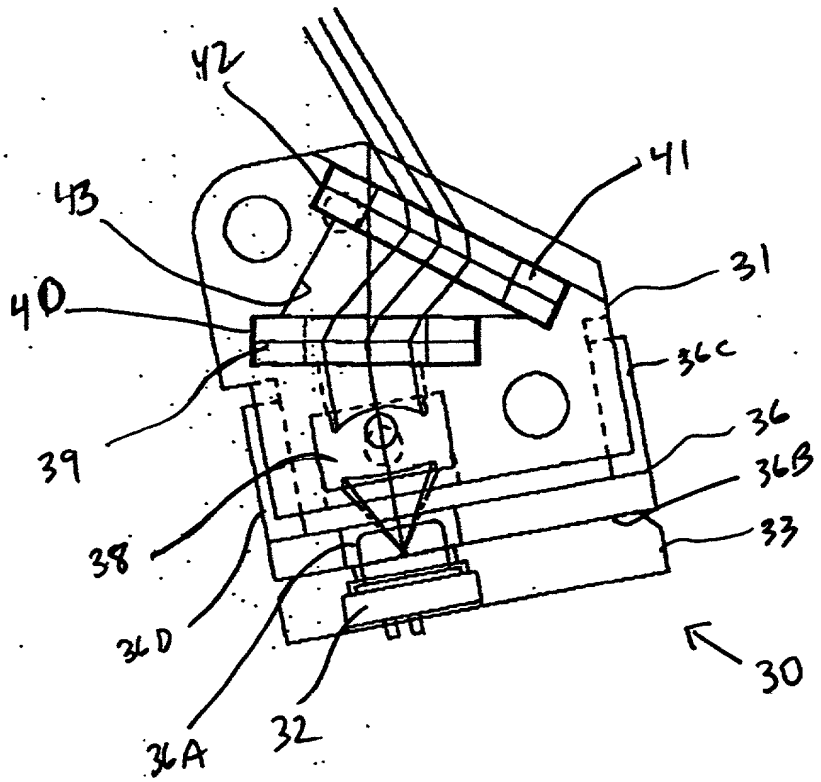


FIG. 7C

0956429-062704

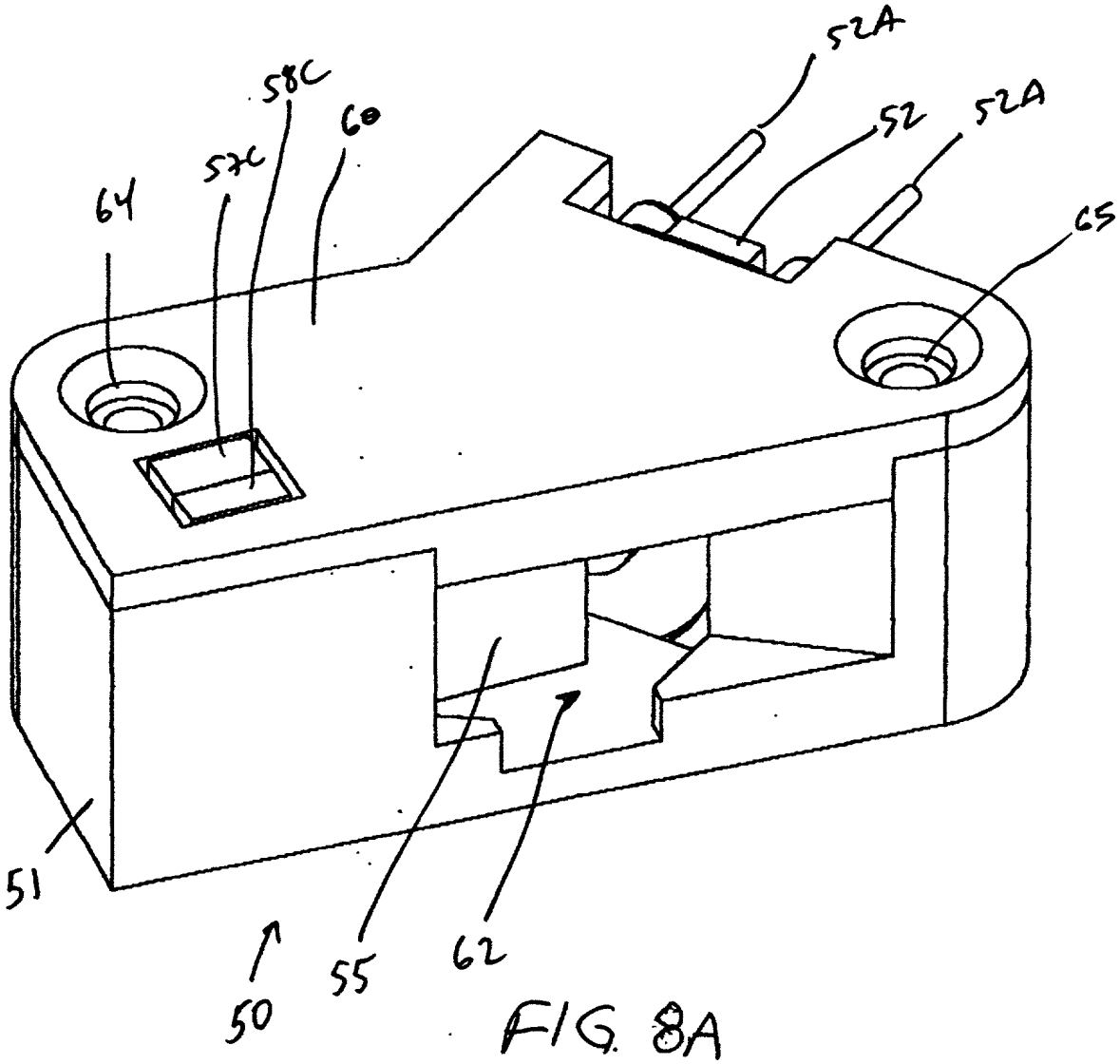


FIG. 8A

WO 2007/095330 PCT/US2007/003830

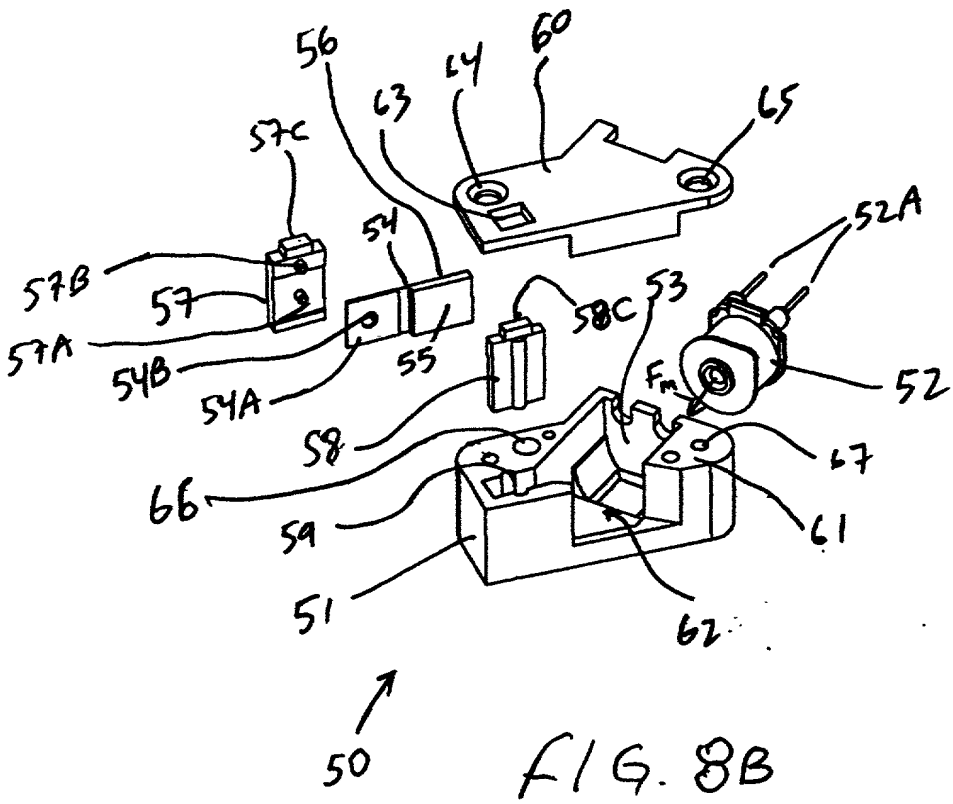

56
64
60
63
65
57C
57B
57
57A
54B
54A
54
55
58C
53
52A
52
F_m
58
66
59
67
61
51
62
50

FIG. 8B

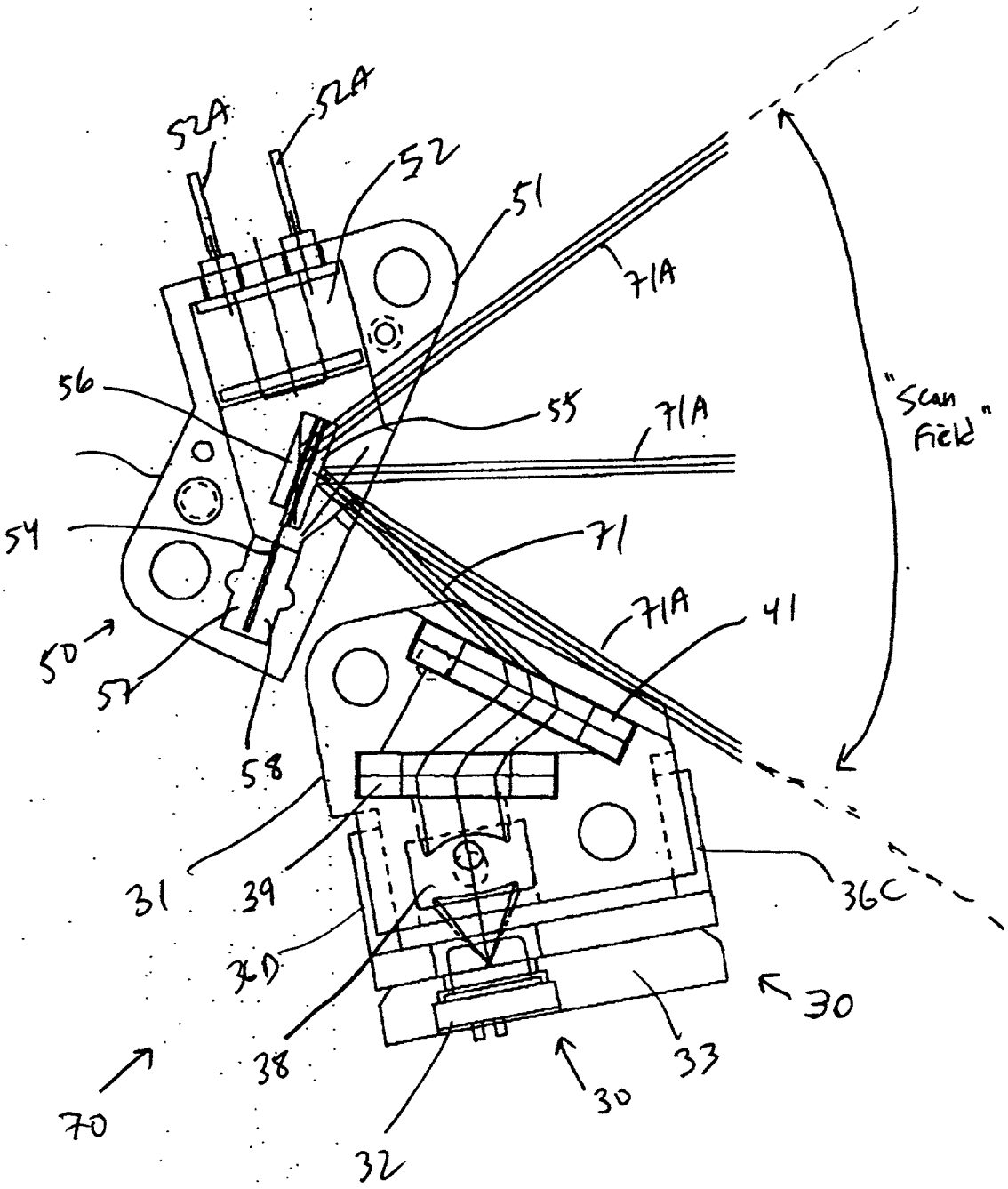


FIG. 9

US 6,369,794 B1

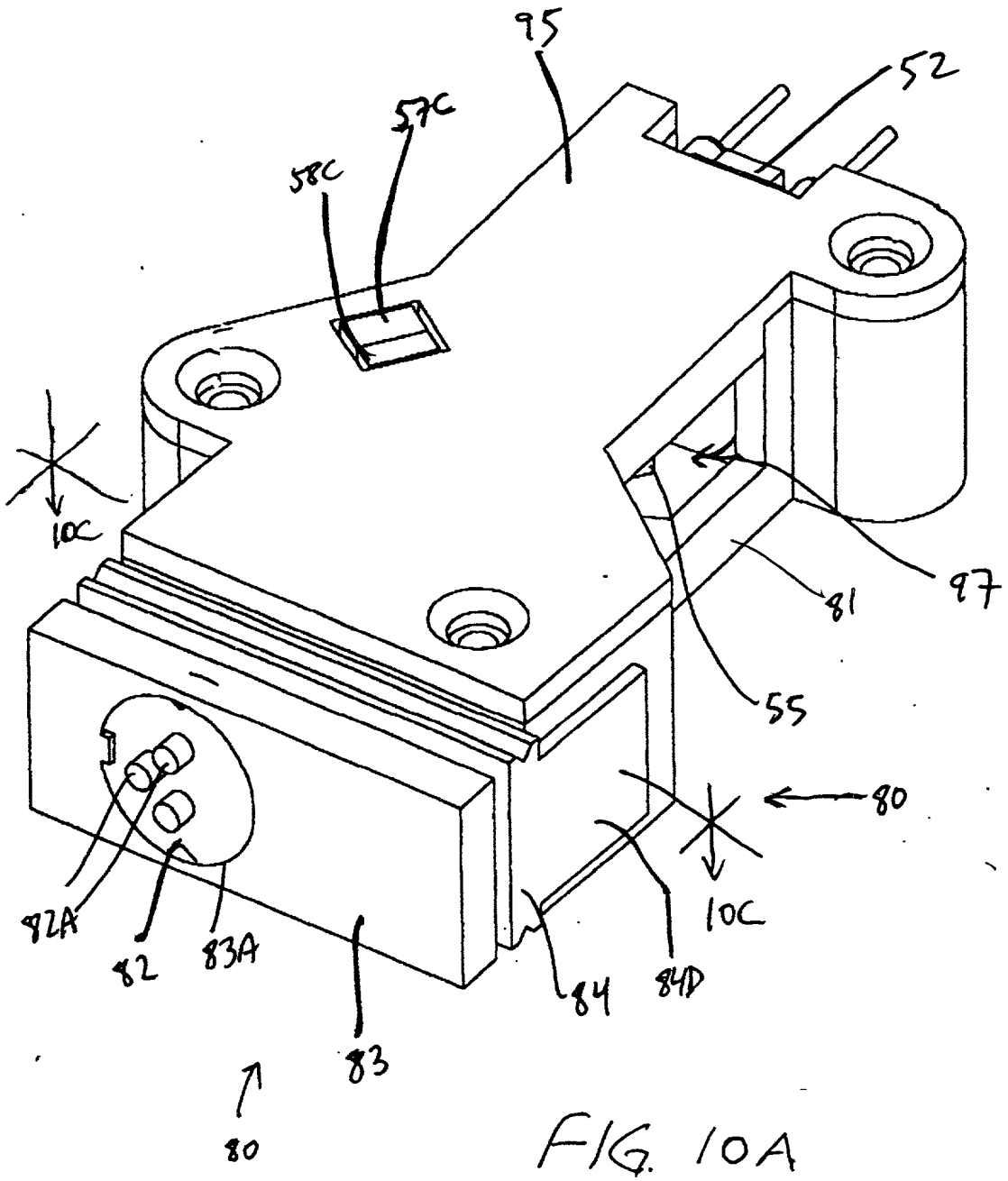


FIG. 10A

05054203 - 082704

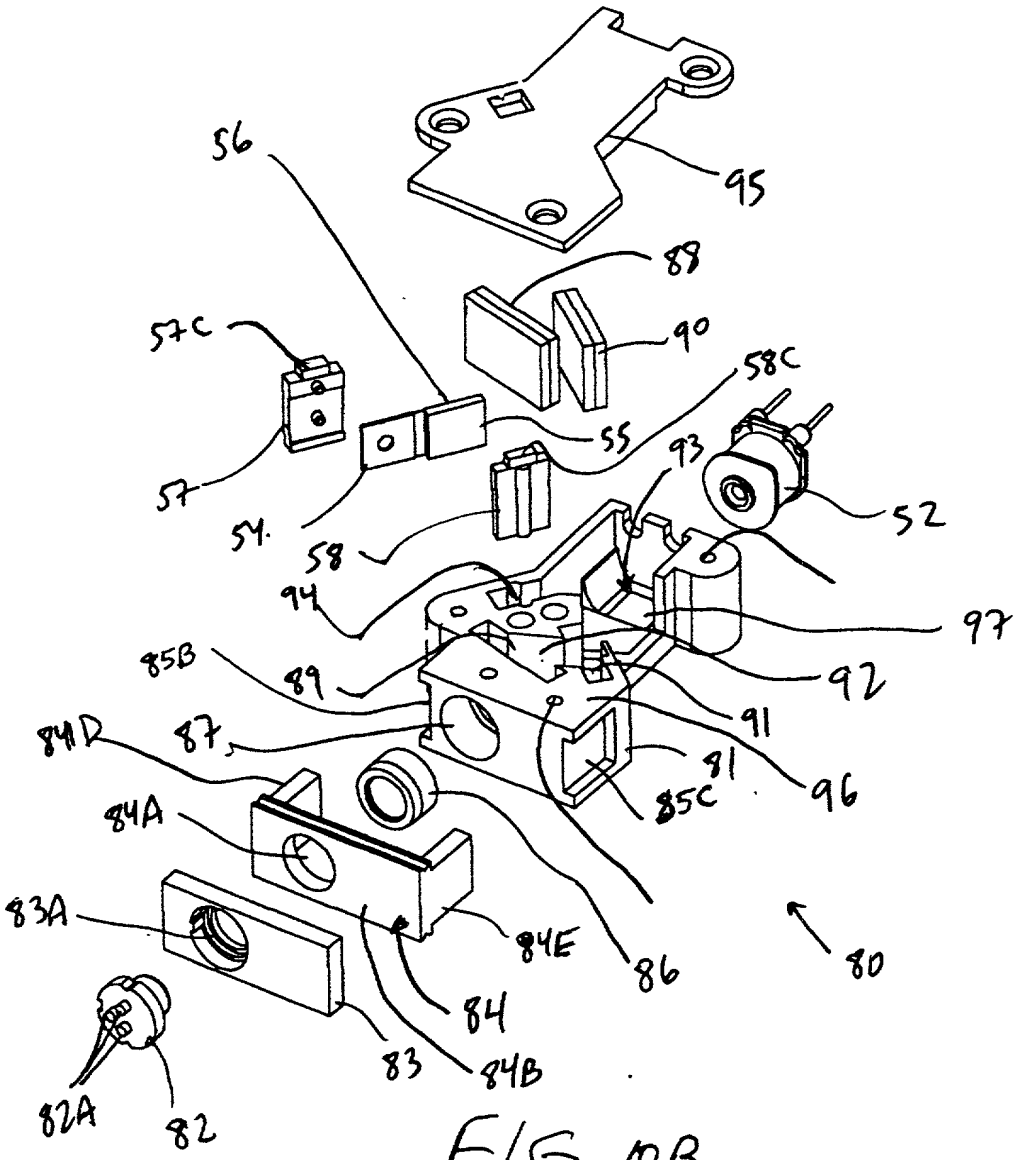


FIG 10B

0956425-000704

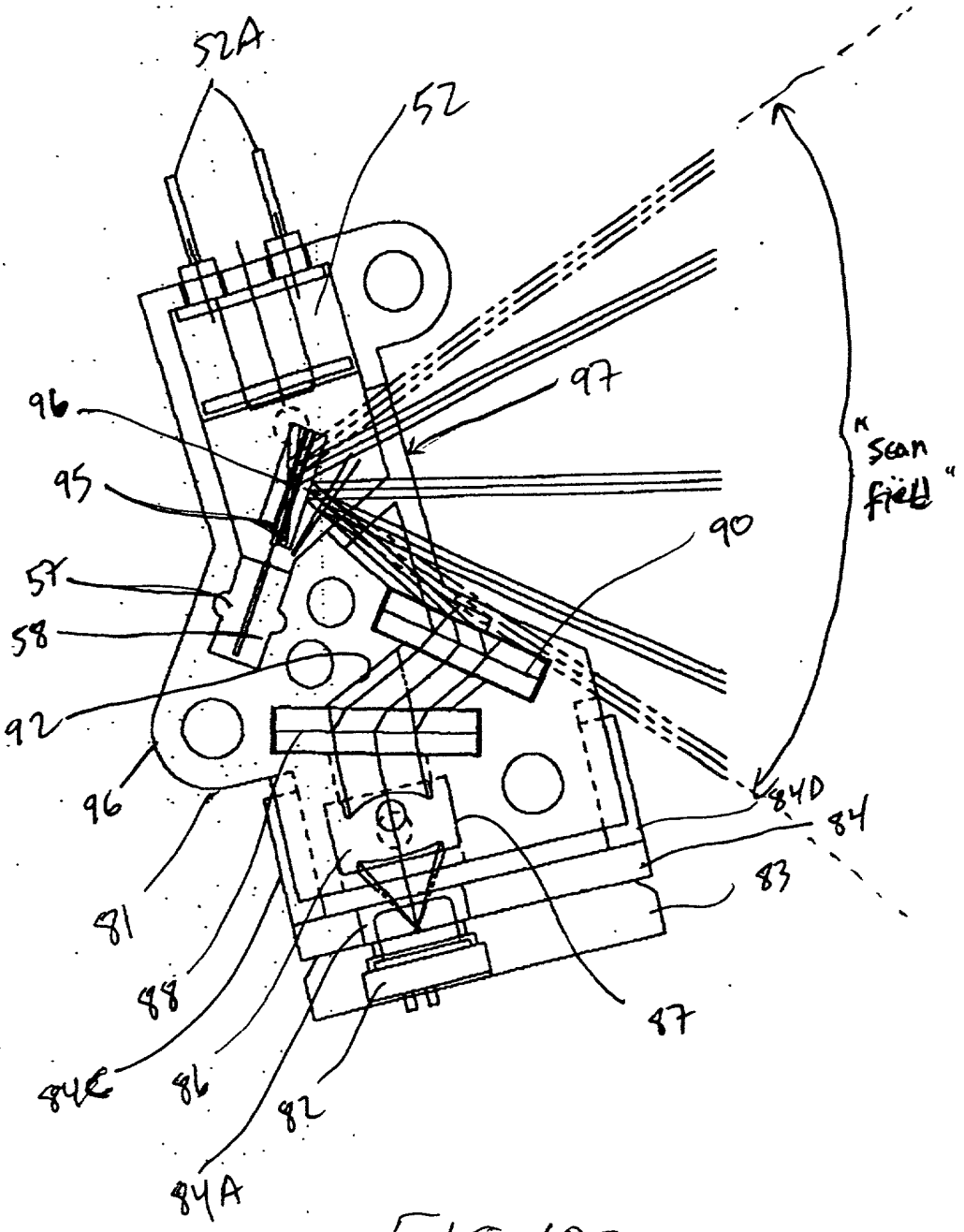


FIG. 10C

WO 2004/042546 PCT/US2003/034570

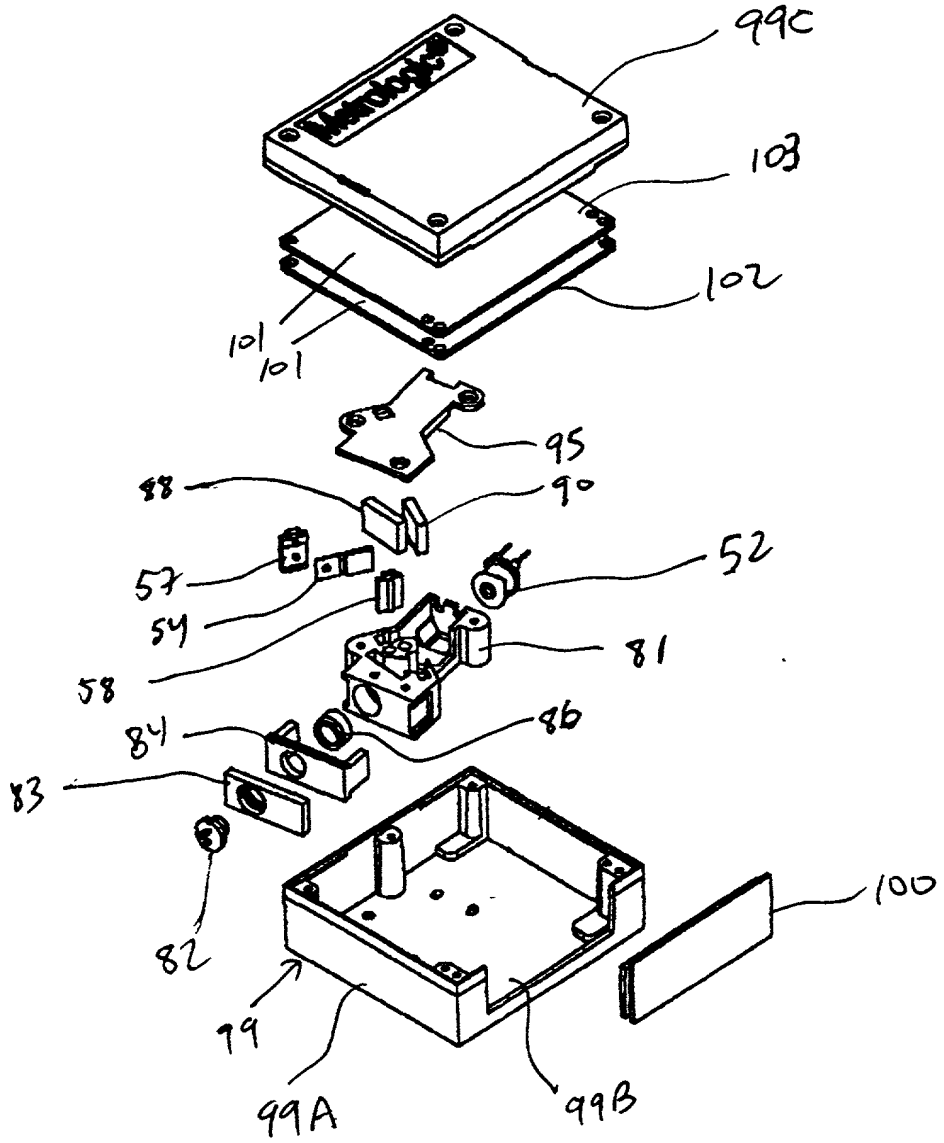


FIG. 10D

0050-0003-0202-01

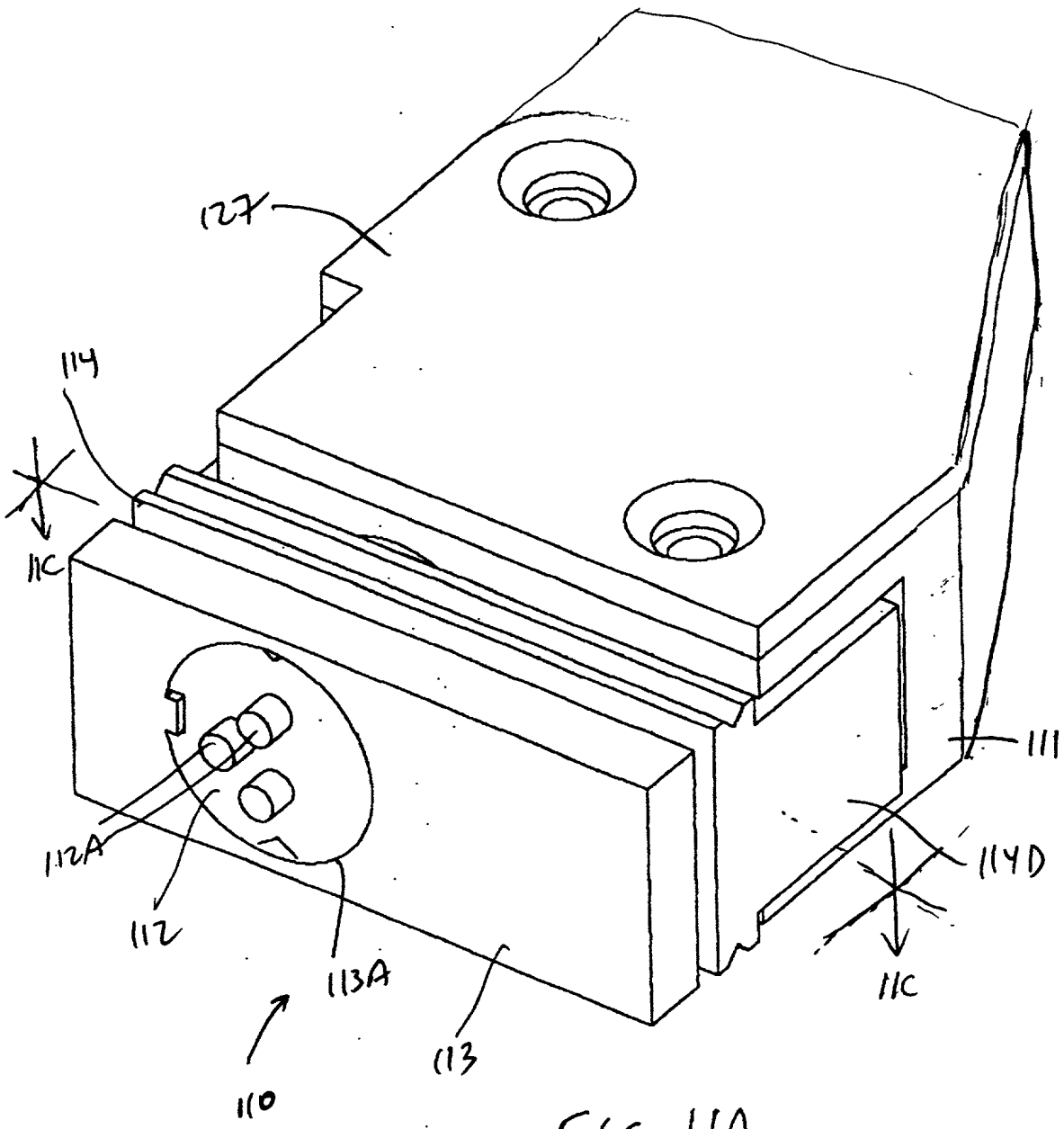


FIG. 11A

DOCKET NO. 2005-0128

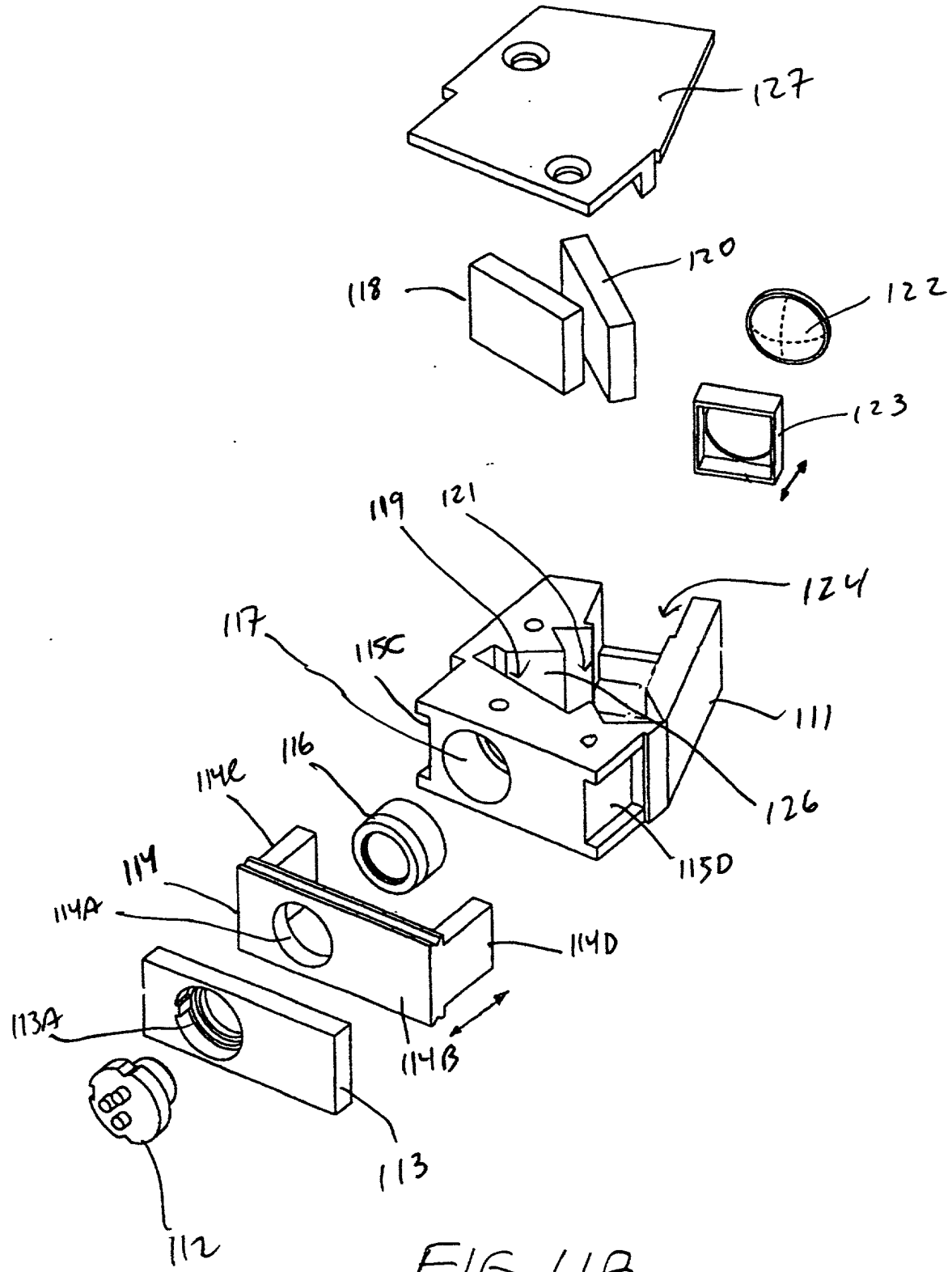


FIG. 11B

US 9,535,253 B2

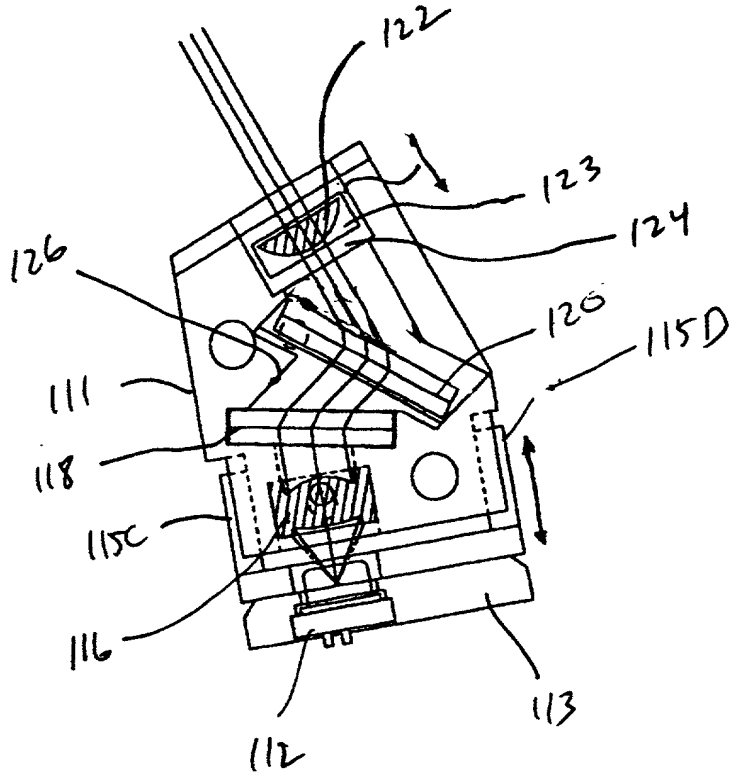


FIG. 11C

09655402 - 090204

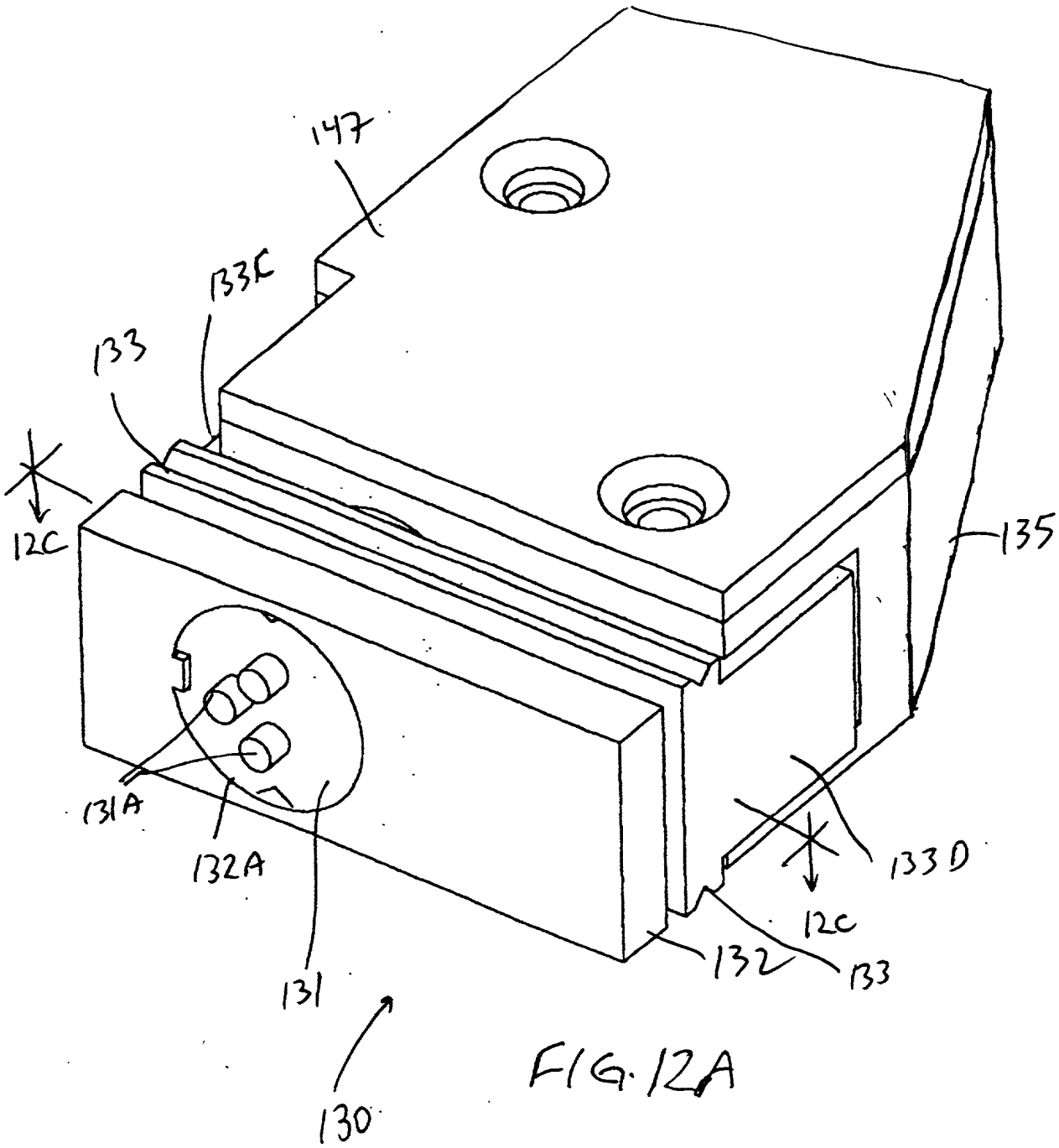


FIG. 12A

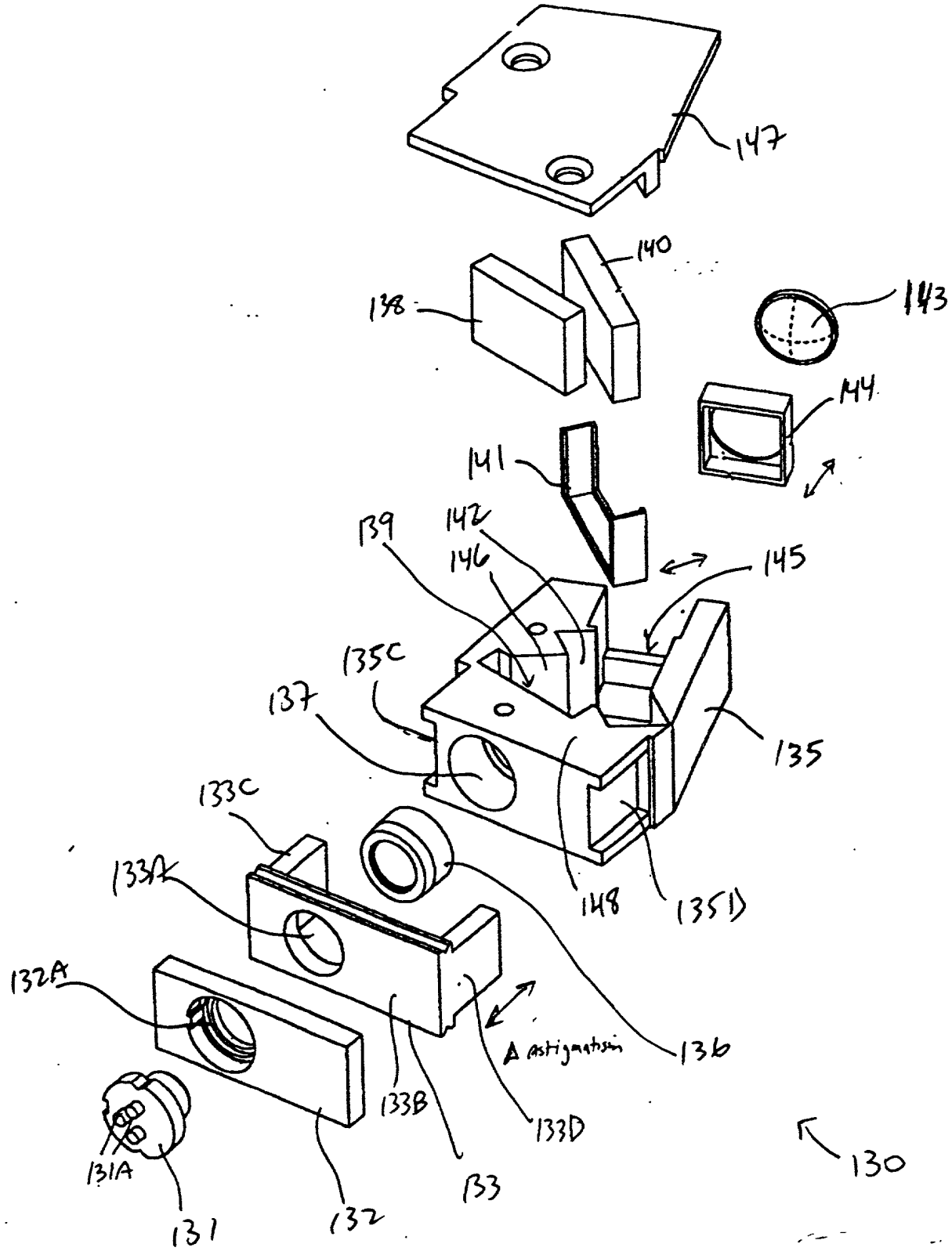


FIG.12B

0085443-0085701

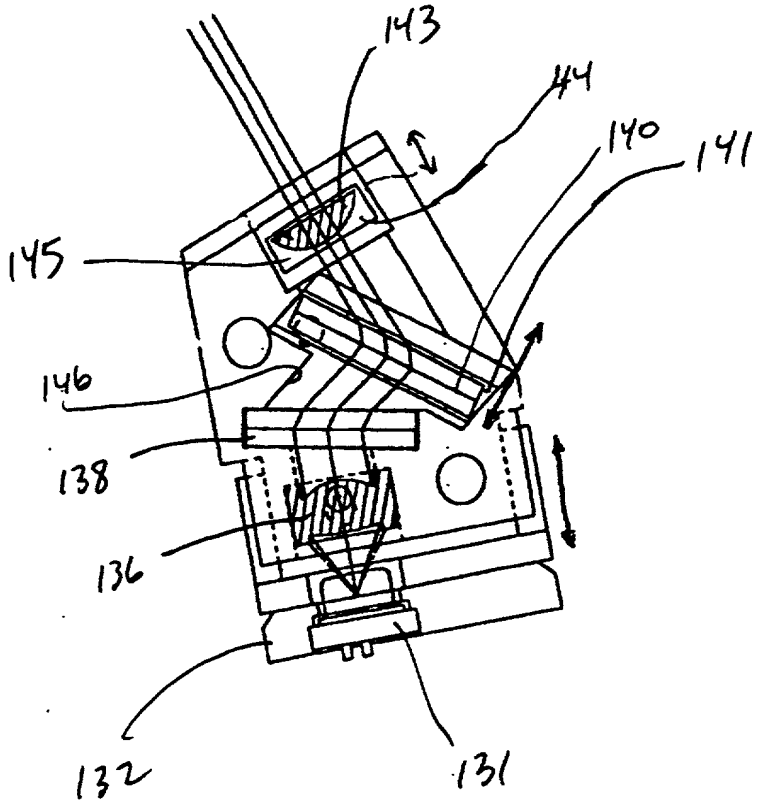


FIG. 12C

WO 2015/095362 PCT/US2014/070949

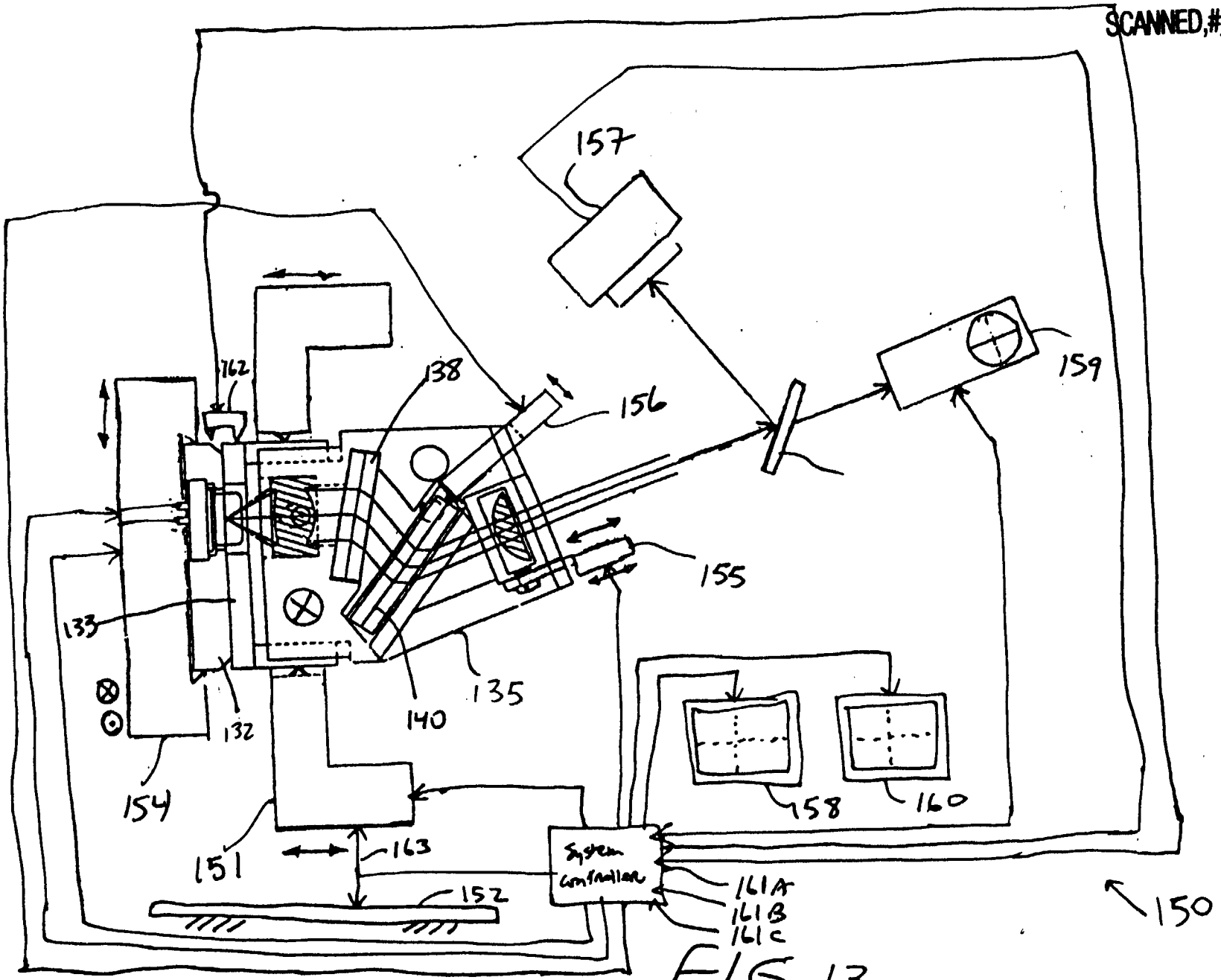

157
159
162
138
156
155
133
135
140
132
154
158
160
151
163
152
System controller
161A
161B
161C
150

FIG. 13

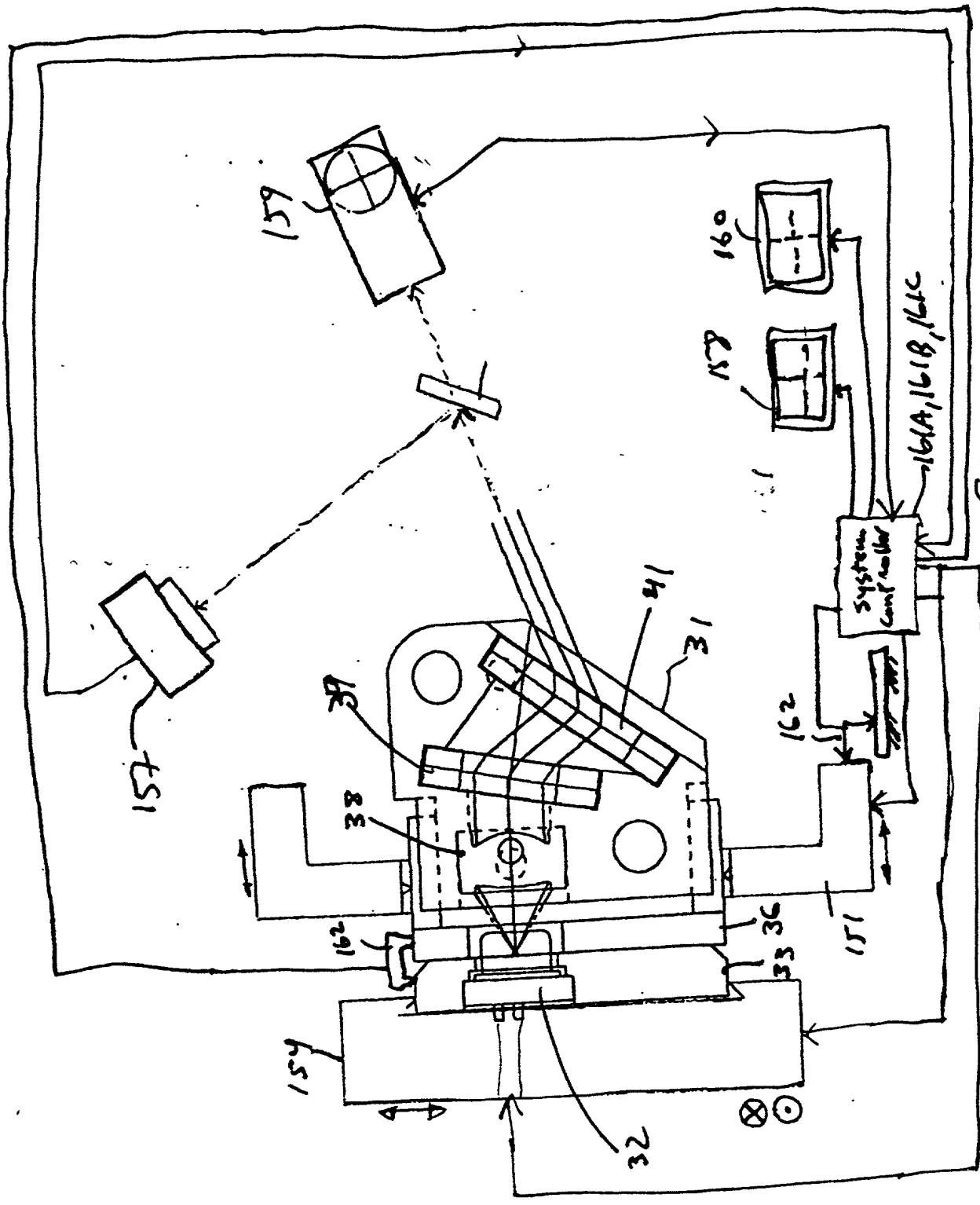


FIG. 14
(Case A)

09652202 - 092704

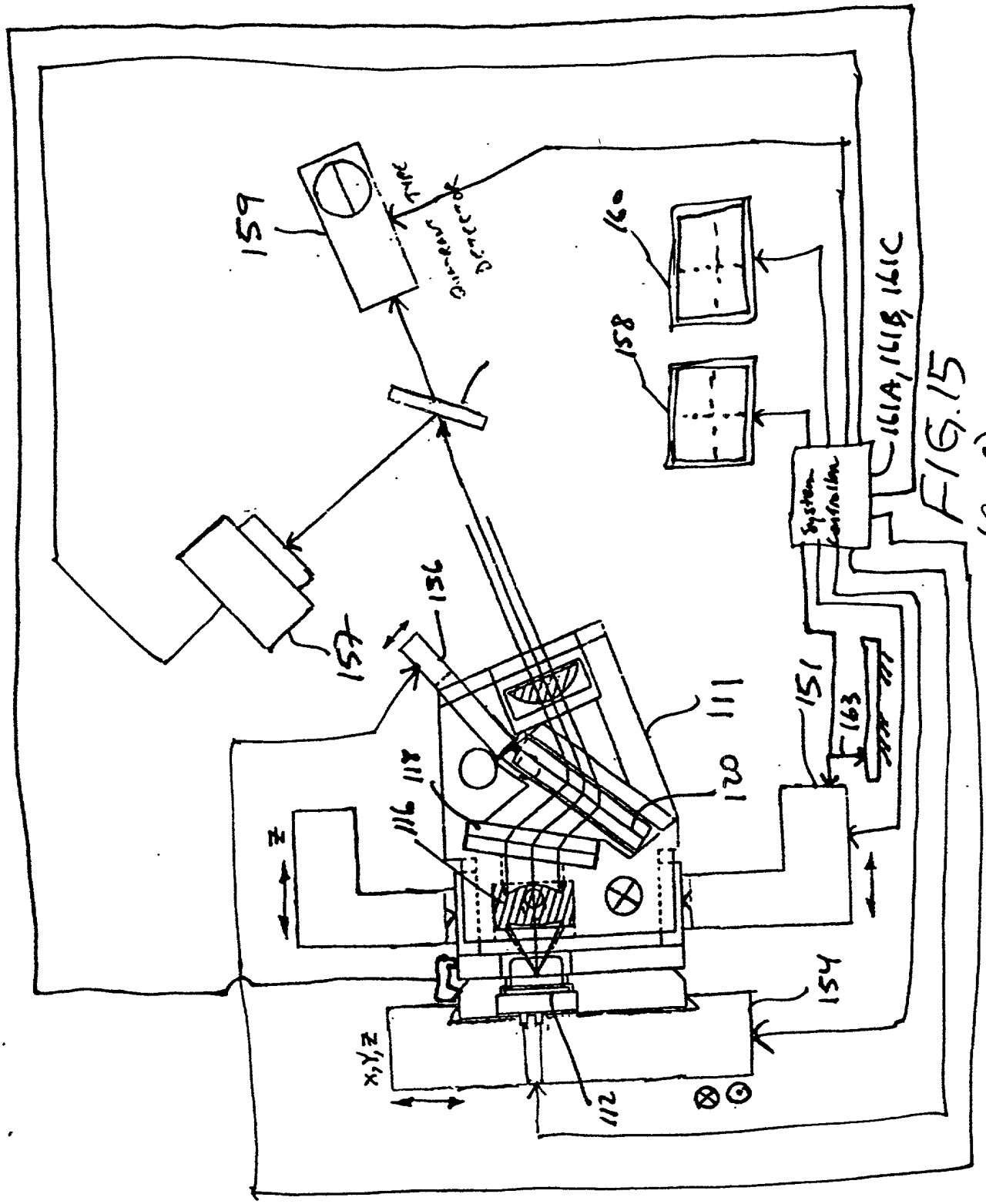


FIG. 15
(Case B)

09/06/2003 - 09:27:04

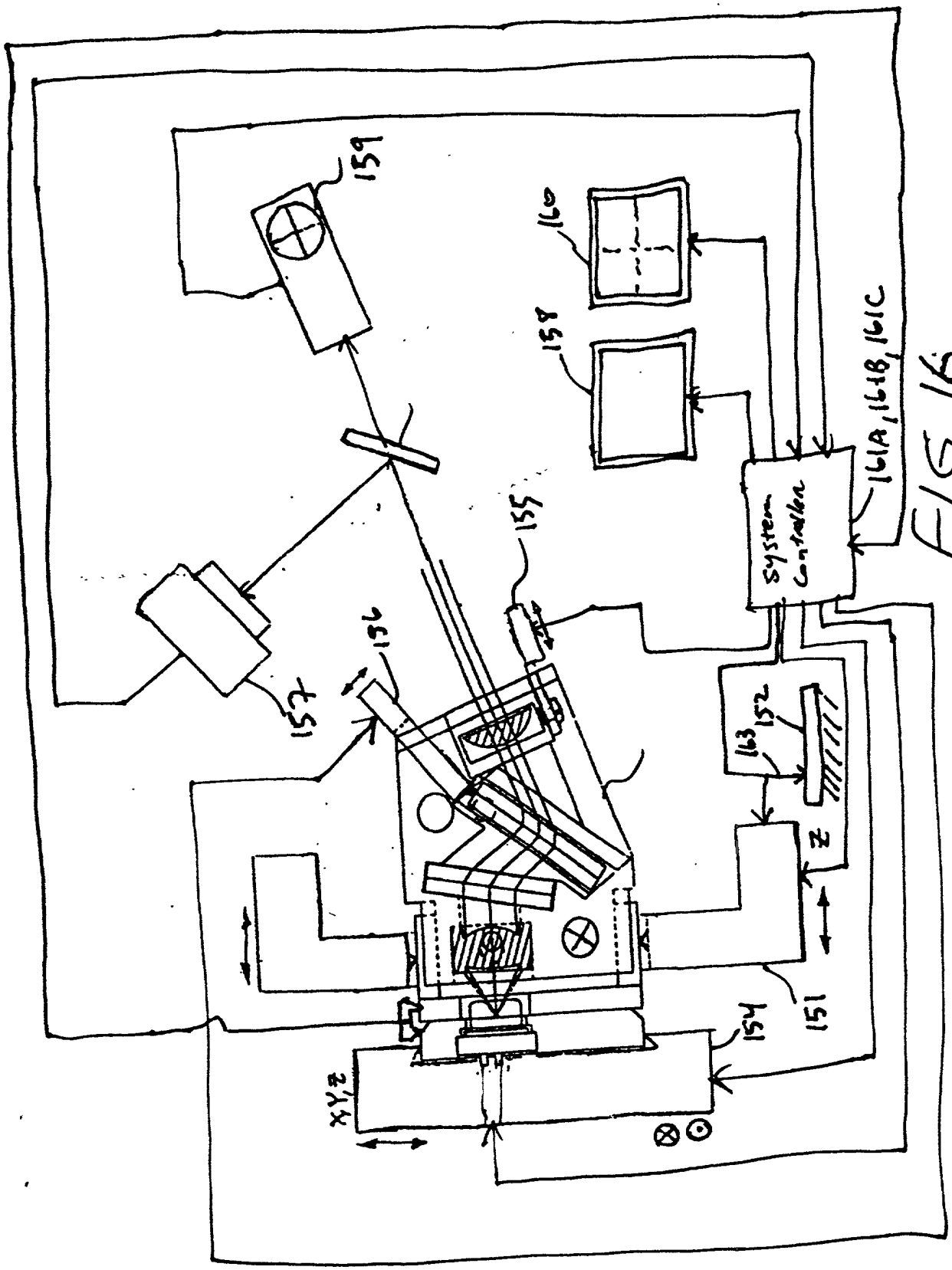


FIG. 16
(Case C)

09655483 - 082704

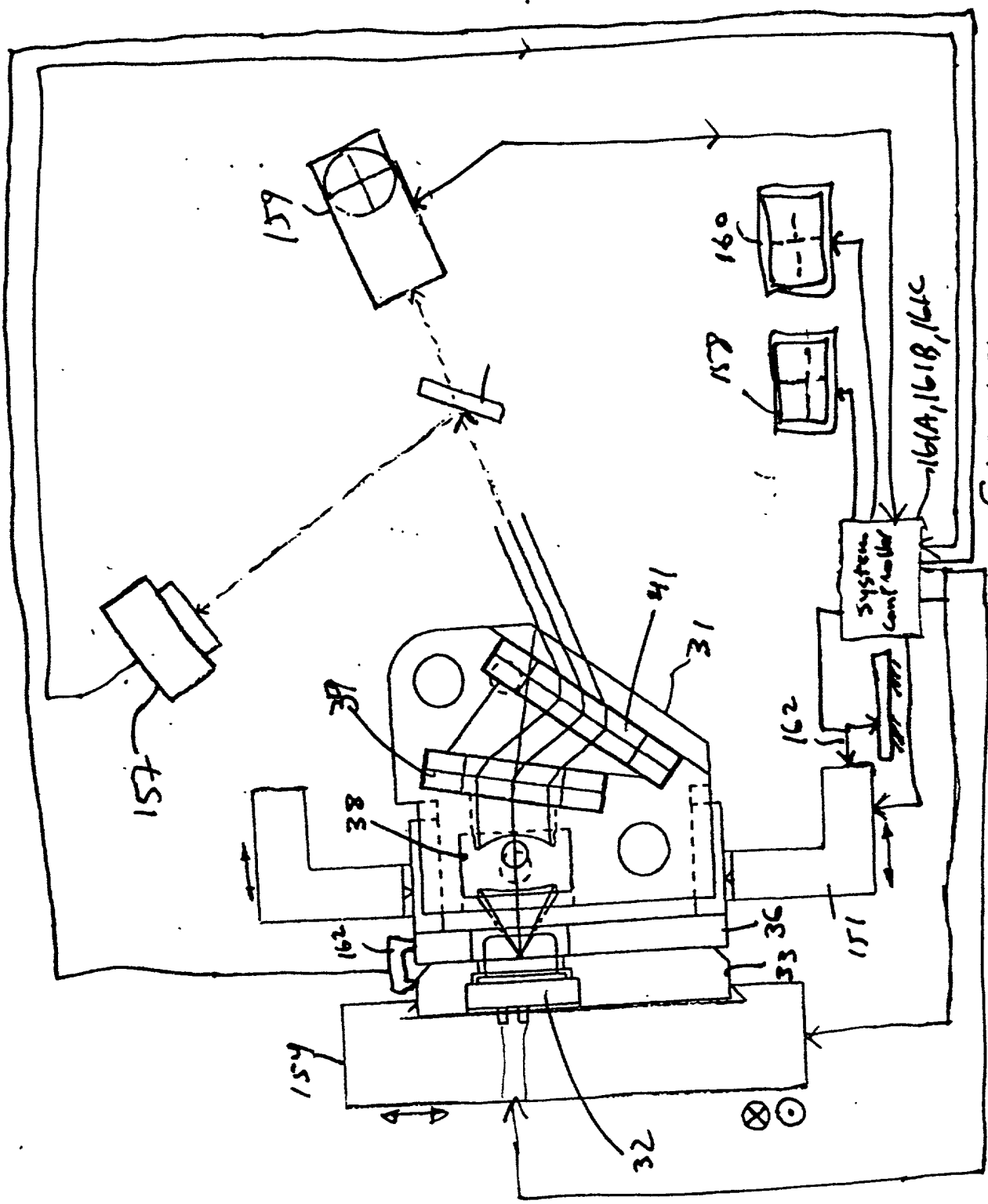


FIG 17

(Cont'd)

10/26/2006 09:55:25

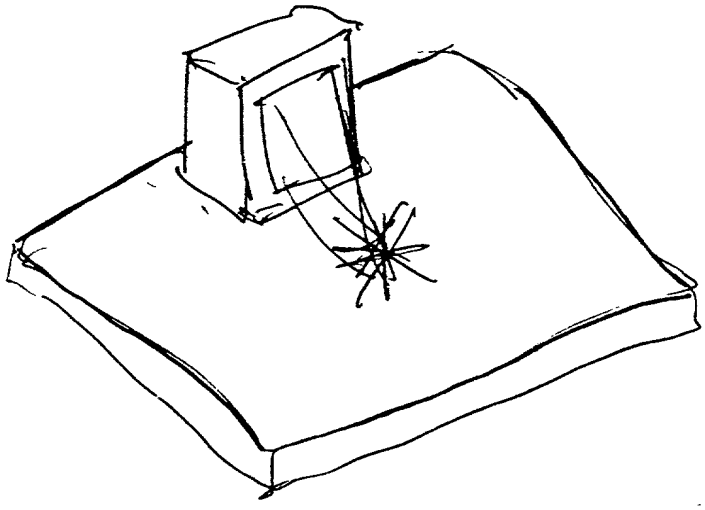


FIG. 19

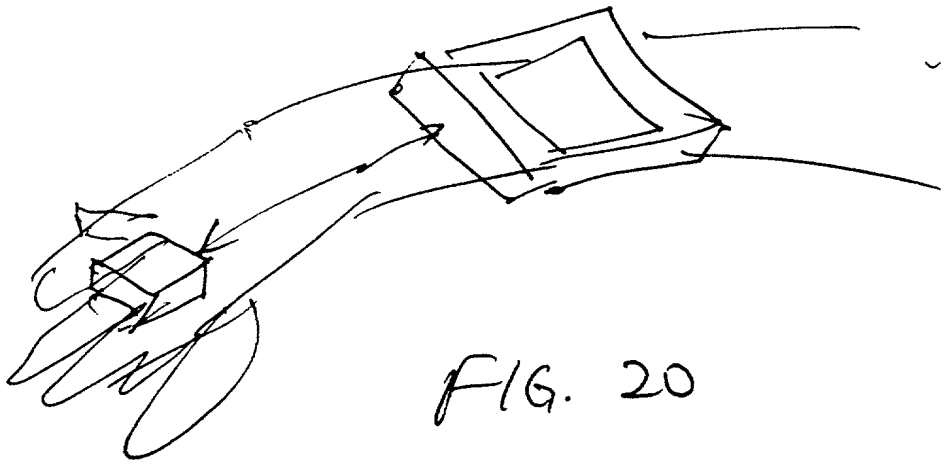
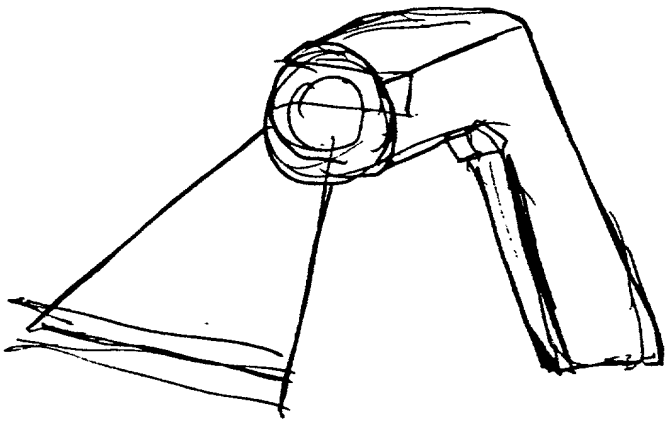


FIG. 20

0606423.060704



Z-D

FIG. 18

08054202 - 082708

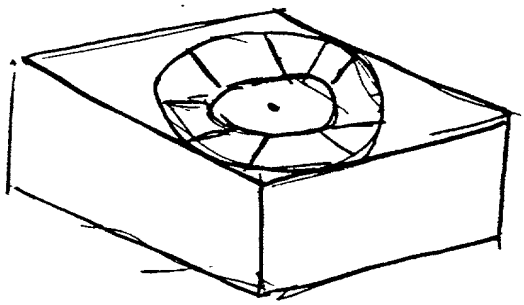


FIG 21

D8656 EP 3 858 656 A1

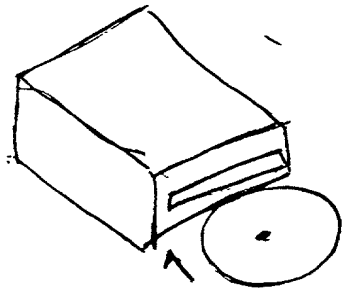


FIG. 22

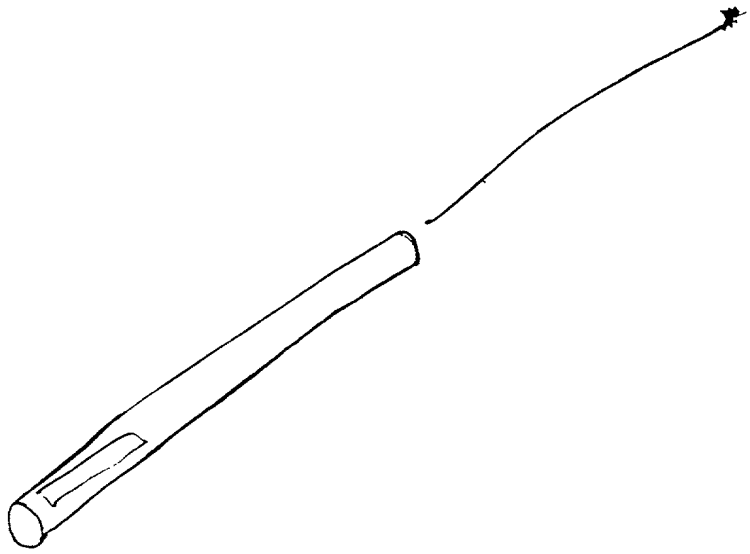


FIG. FIG. 23

D695,342 - 05/21/13

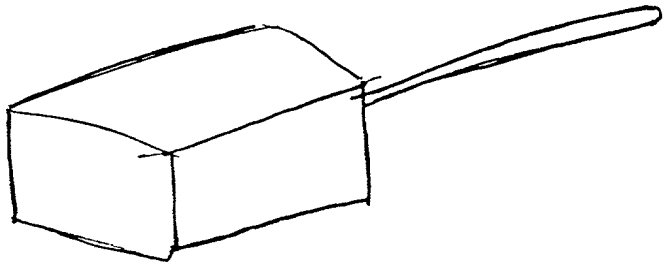


FIG. 24

D0865428 - 090208